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Vol. II

STATE DOCUMENTS
OCT 25 '77

FINAL ENVIRONMENTAL IMPACT STATEMENT
FOR THE
PROPOSED EXPANSION OF WESTERN ENERGY COMPANY'S
ROSEBUD MINE
INTO
AREAS A AND E

VOLUME II
APPENDICES

MONTANA DEPARTMENT OF STATE LANDS
Helena, Montana
September 6, 1977

Submitted pursuant to
Montana Environmental Policy Act

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APPENDICES PAGE

A. Climate and Air Quality A-1
B-1. Soil Descriptions and Soil Test Data B1-1
B-2. Overburden Analyses - Mine Areas A and E B2-1
C. Hydrology C-1
D-1. Detailed Description of Community Types in Areas A and E D1-1
D-2. Descriptions of Acreages and Productivity of Burlington-Northern Croplands in Area A and Productivity Data for Community Types in Area E D2-1
D-3. Plant List Species D3-1
D-4. Species of Wildlife in the Region D4-1
D-5. Description of Area E Graded Spoils Research Area D5-1
E-1. Yellowstone River Sub-Basin Use E1-1
E-2. Sector Employment and Sector Income Per Employee E2-1
E-3. Detailed Descriptions of Rosebud County's School Districts E3-1
E-4. Highway Status - Rosebud County Average Daily Traffic Counts E4-1
E-5. Correspondence Concerning the Surge Pond Recreation Area E5-1
E-6. Evaluation of Landscapes within a One-day Traveling Distance E6-1
E-7. Economic-Demographic Simucation Model E7-1
F. Correspondence and Public Comments and Responses on the Draft Impact Statement F-1

APPENDIX A

CLIMATE AND AIR QUALITY

CONTENT

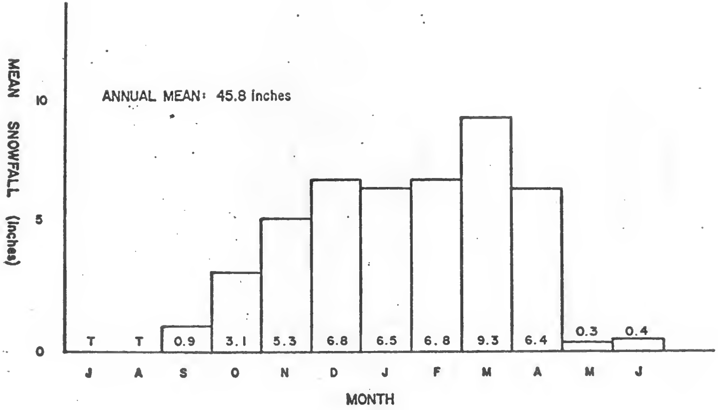
An Analysis of the Precipitation Record for Colstrip and Crow Agency, Montana, by John R. McBride

Figure 1. Mean Monthly Snowfall - Colstrip, Montana
Table 1. Mean Evaporation - Terry, Montana
Table 2. State of Montana Ambient Air Quality Standards
Table 3. Federal Primary and Secondary Air Quality Standards
Table 4. Average Emission Rates for Heavy-Duty Diesel-Powered and Gasoline-Powered Construction Equipment

Figure 1

MEAN MONTHLY SNOWFALL
Colstrip, Montana[a]

(From U. S. Department of Commerce, 1965)



[a] BASED ON RECORDS FROM 26–29 YEARS PRIOR TO AND INCLUDING 1960

TABLE 1

MEAN EVAPORATION (INCHES)[a]
TERRY, MONTANA

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr
Mean Evaporation	-	-	-	-	8.51	9.93	10.91	9.59	5.99	-	-	-	-
Years of Record					5	7	9	9	10				

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[a] U.S. Department of Commerce, 1965

An analysis of the precipitation record for Colstrip and Crow Agency, Montana, a preliminary report to the Montana Department of State Lands, Helena, MT, unpublished manuscript, Dept. of Geology, University of Montana. by John R. McBride, 1976.

For Colstrip Montana continuous monthly and annual precipitation data exist for the period 1928-1974. Annual, growing season (April-September), five year average annual, and five year average growing season precipitation frequency probability plots were calculated for these data. These plots permit the determination of the probability of occurrence of a given precipitation quantity. In addition, similar calculations were performed for the precipitation record of Crow Agency, Montana. Since Crow Agency has a precipitation record dating back to 1879 and is climatically similar to Colstrip, this record is particularly valuable in assessing the climate prior to the installation of precipitation measuring equipment at Colstrip, Montana. Finally, a Thornthwaite potential evapotranspiration index was calculated for several stations in Southeastern Montana to further define the nature of the Climate in the Colstrip vicinity.

The following observations can be made based on a preliminary review of the above calculations:

1. The recent reclamation efforts in Eastern Montana have indeed taken place during an unusually optimum moisture phase. For the precipitation record at Colstrip, Montana, the past five years' average precipitation ranks fourth out of forty-four (probability of occurrence less than one in ten). The average growing season precipitation at Colstrip for the last five years ranks fifteenth out of forty-four. The "optimum" nature of recent precipitation is much more strikingly shown in the Crow Agency record. The average annual precipitation for the last five years at Crow Agency ranks second out of seventy-four (probability of occurrence less than one in thirty-three). The five year average growing season precipitation in the recent past is the highest on record. The period 1968-1972 ranks first out of eighty, 1967-1971 ranks second, 1969-1973 ranks third, 1964-1968 is fourth, 1971-1975 is fifth, 1964-1968 is sixth, 1966-1970 is tied for ninth, and 1965-1969 is eleventh.

2. Unusually large precipitation events have also occurred in the coal regions of Southeastern Montana. In fact, the "optimum" nature of current precipitation conditions at Colstrip is partially masked due to the influence of a single months' precipitation. In June, 1944 10.28 inches of rain fell at Colstrip, Montana. The growing season precipitation total for 1944 was 21.34 inches, almost twice the average for the period of record. The probability of occurrence of an event of this magnitude has not yet been calculated, but it

is undoubtedly extremely small. This events' influence is demonstrated by the fact that the five year growing season averages which contain the year 1944 rank one through five out of forty-four. A precipitation event of this magnitude has obvious erosion potential.

3. The cyclic nature of the Crow Agency precipitation record is further demonstrated by the fact that the lowest five year growing season averages (rank 75-80) are all in the 1930's.

4. The drought of the 1930's was accompanied by a disproportionate decrease in growing season precipitation. Average precipitation for the period 1930-1939 was 87% of the average for the period of record at Colstrip, Montana. However, the average growing season precipitation for the same period was only 77% of the average for the period of record.

5. The similar nature of the climatic record of Colstrip and Crow Agency is evidenced by the fact that their Thornthwaite P.E. Index values are essentially identical.

It should be noted that the climatic analyses performed here are preliminary in nature and represent only a very beginning of the regional climatic analysis that should be performed. The cyclic nature of the climatic record of Eastern Montana should be explored in much more detail. Considerable effort has been expended in the last few years to project levels of coal mining and energy conversion development in Eastern Montana. A similar effort should now be undertaken to determine the potential for reclamation success in various locations and the influence of climate and climatic cycles on such success.

TABLE 2 Sheet 1 of 2

STATE OF MONTANA AMBIENT AIR QUALITY STANDARDS[a]

Pollutants	Standards (Maximum permissible concentrations)
Sulfur dioxide	0.02 ppm, maximum annual average 0.10 ppm, 24-hour average, not to be exceeded over 1 percent of the days in any 3-month period 0.25 ppm not to be exceeded for more than 1 hour in any 4 consecutive days
Reactive sulfur (sulfation)	0.25 milligrams sulfur trioxide per 100 square centimeters per day, maximum annual average 0.50 milligram sulfur trioxide per 100 square centimeters per day, maximum for any 1-month period
Suspended sulfate	4 micrograms per cubic meter of air, maximum allowable annual average 12 micrograms per cubic meter of air, not to be exceeded over 1 percent of the time
Sulfuric acid mist	4 micrograms per cubic meter of air, maximum allowable annual average 12 micrograms per cubic meter of air, not to be exceeded over 1 percent of the time 30 micrograms per cubic meter of air, hourly average, not to be exceeded over 1 percent of the time
Hydrogen sulfide	0.03 ppm, 1/2-hour average, not to be exceeded more than twice in any 5 consecutive days 0.05 ppm, 1/2-hour average, not to be exceeded over twice a year

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[a] From The Bureau of National Affairs, 1975

TABLE 2 Sheet 2 of 2

Pollutants	Standards (Maximum permissible concentrations
Total suspended particulate	75 micrograms per cubic meter of air, annual geometric mean 200 micrograms per cubic meter of air, not to be exceeded more than 1 percent of days a year
Settleable particulate (dustfall)	15 tons per square mile per month, 3-month average in residential areas 30 tons per square mile per month, 3-month average in heavy industrial areas
Lead	5.0 micrograms per cubic meter of air, 30-day average
Beryllium	0.01 micrograms per cubic meter of air, 30-day average
Fluorides, total (as HF) in air	1 part per billion parts of air, 24-hour average
Fluorides (as F) in forage for animal consumption - dry weight basis	35 parts per million
Fluorides (gaseous)	0.3 micrograms per square centimeter per 28 days

TABLE 3

FEDERAL PRIMARY AND SECONDARY AIR QUALITY STANDARDS[a]

Pollutant	Averaging Time	Federal Primary Standard	Federal Secondary Standard
Nitrogen Dioxide[b]	Annual Average	0.05 ppm[c] (100 $\mu g/m^3$)[d]	0.05 ppm (100 $\mu g/m^3$)
Sulfur Dioxide	Annual Average	0.03 ppm (80 $\mu g/m^3$)	-
	24 Hour	0.14 ppm (365 $\mu g/m^3$)	-
	3 Hour	-	0.05 ppm (1300 $\mu g/m^3$)
Suspended Particulate	Annual Geometric Mean	75 $\mu g/m^3$	60 $\mu g/m^3$
	24 Hour	260 $\mu g/m^3$	150 $\mu g/m^3$
Hydrocarbons (corrected for methane)	3 Hour 6:00-9:00 a.m.	0.24 ppm[e] (160 $\mu g/m^3$)	0.24 ppm (160 $\mu g/m^3$)
Photochemical Oxidants	1 Hour	0.08 ppm (160 $\mu g/m^3$)	0.08 ppm (160 $\mu g/m^3$)
Carbon Monoxide	8 Hour	9 ppm (10 mg/m^3)[f]	9 ppm (10 mg/m^3)
	1 Hour	35 ppm (40 mg/m^3)	35 ppm (40 mg/m^3)

All standards except annual average are not to be exceeded more than once a year.

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[a] From the Bureau of National Affairs, 1975.

[b] Nitrogen dioxide is the only one of the nitrogen oxides considered in the ambient standards.

[c] ppm = parts per million

[d] $\mu g/m^3$ = micrograms per cubic meter

[e] Maximum 3-hour concentration between 6:00 - 9:00 a.m.

[f] mg/m^3 = milligrams per cubic meter

TABLE 4

AVERAGE EMISSION RATES FOR HEAVY-DUTY DIESEL-POWERED AND GASOLINE-POWERED CONSTRUCTION EQUIPMENT

(grams per second - U.S. EPA, 1976)

	Carbon Monoxide	Exhaust Hydro-carbons	Nitrogen Oxides (NO_2)	Sulfur Oxides (SO_2)	Particulates
Diesel-Powered					
Tracklaying tractor	< 0.1	< 0.1	0.2	< 0.1	< 0.1
Wheeled tractor	0.3	< 0.1	0.1	< 0.1	< 0.1
Wheeled dozer	0.1	< 0.1	0.6	< 0.1	< 0.1
Scraper	0.2	0.1	0.8	0.1	0.1
Motor grader	< 0.1	< 0.1	0.1	< 0.1	< 0.1
Wheeled loader	0.1	< 0.1	0.3	< 0.1	< 0.1
Tracklaying loader	< 0.1	< 0.1	0.1	< 0.1	< 0.1
Off-highway truck	0.2	0.1	1.0	0.1	< 0.1
Roller	< 0.1	< 0.1	0.1	< 0.1	< 0.1
Miscellaneous	0.1	< 0.1	0.3	< 0.1	< 0.1
Gasoline-Powered					
Wheeled tractor	1.2	< 0.1	0.1	< 0.1	< 0.1
Motor grader	1.5	0.1	< 0.1	< 0.1	< 0.1
Wheeled loader	2.0	0.1	0.1	< 0.1	< 0.1
Roller	1.7	0.1	< 0.1	< 0.1	< 0.1
Miscellaneous	2.1	0.1	0.1	< 0.1	< 0.1

APPENDIX B-1

SOIL DESCRIPTIONS AND SOIL TEST DATA

CONTENT

Soil Series Descriptions and Analyses Results for Rosebud Mine Areas A and E, Colstrip, Montana

CUSHMAN SERIES

The Cushman Series consists of moderately deep, well-drained soils formed from weathered soft sandstone and siltstone. They occupy uplands and are underlain by sandstone and siltstone, at depths of 20 to 40 inches. Annual precipitation is 10 to 14 inches.

In a representative profile the surface layer is grayish-brown loam about 6 inches thick. The subsoil is brown clay loam about 2 inches thick. Below this lies a calcareous loam which grades to fine sandy loam. This merges with soft sandstone and shale at about 38 inches. Slopes are 2 to 8 percent.

Permeability is moderate and runoff is medium.

Typifying Pedon:

Typical profile of Cushman loam, 2 to 8 percent slopes:

Ap-0-6 inches, light brownish-gray (2.5y 5/2) loam, dark grayish-brown (2.5y 4/2) moist; moderate fine crumb structure; soft when dry, very friable when moist and nonsticky and nonplastic when wet; clear wavy boundary.

B2t-6-8 inches., brown (10yR 5/3) clay loam, dark brown (10yR 4/3) moist; moderate medium prisms that separate to moderate medium and fine subangular blocks; hard, friable, sticky and plastic; clay films on pads; common fine and very fine roots; many fine and very fine pores; no effervescence; clear wavy boundary.

B3ca-8-18 inches, light gray (2.5y 7/2) heavy loam, olive brown (2.5y 4/3) moist; weak coarse plates that separate to moderate medium and fine subangular blocks; hard, friable, slightly stick and slightly plastic; common fine and very fine roots; many fine and very fine pores; strong effervescence; common films of lime; clear wavy boundary.

C1ca-18-24 inches, light gray (2.5y 7/3) fine sandy loam, light olive brown (2.5y 5/4) moist; massive; very hard, very many fine and very fine pores; strong effervescence; many fine filsm.and threads of lime; diffused boundary.

C2-24-48 inches, light yellowish-brown (2.5y 6/3) fine sandy loam, light olive-brown (2.5y 5/4) moist; massive; hard, very friable, non-sticky and non-plastic; few very fine roots; common fine and very fine pores; strong effervescence.

C3-38-50 inches, pale-brown, soft, shattered, well-weathered sandstone and residual loamy fine sand; sandstone fragments are undercoated with lime.

Cushman loam, 2 to 8 percent slopes (Ca). This soil is located on gently and moderately sloping uplands. The profile is typical for the series.

Risk of erosion is moderate for water and slight for wind.

Recommendations for Stockpiling:
The top 3 feet of soil are well suited for stockpiling. Locally the material is suitable to a depth of 4 to 6 feet. It is easily worked, has high natural fertility and roots penetrate well. The underlying soft sandstone and loamy shale is undesirable for stockpiling because of slow infiltration and slow internal permeability.

Do Not Write This Space

Date Rec'd. ____________

Date Sent ____________

RESULTS OF DEEP SOIL SAMPLE ANALYSIS

FROM:

Montana Testing Laboratories, Inc.
P. O. Box 3013
Great Falls, Montana 59401

FOR: (Grower) Western Energy

Area A1 Step 19 Ca Cushman

CLIENT: (Dealer) ____________

Lab No.	Your Field No	Depth (Inches)	pH	Organic Matter %	Nitrate Nitrogen ppm	Lbs./Ac. N	Phosphorus P ppm	Potassium K ppm	Calcium Ca meq/100g	Magnesium Mg meq/100g	Sodium Na meq/100g	Salt Hazards mmhos	Soil Texture	Available H2O (Inches)
8999		0-6	6.5	0.08	1.85		5.0	350	18.5	5.0	0.3	0.4	L	LIME S
9000		6-8	6.7	0.08	0.25		7.7	238	21.1	5.3	0.1	0.4	L	S
9001		8-18	7.2	0.8	0.25		2.5	63	+35	4.5	0.1	0.4	L	M+
9002		18-24	7.6	0.08	0.25		17.5	83	33.3	4.8	0.1	0.3	FSL	M+
9003		24-38	7.7	0.08	0.5		2.5	2.5	+35	8.0	0.1	0.4	FSL	M+
9004		38-50	7.9	0.08	0.5		5.0	2.5	32.0	5.9	0.1	0.4	FSL	M+

OTHER TESTS REQUIRED

Sulfur ppm	Zinc ppm	Iron ppm	Copper ppm	Manganese ppm	Boron ppm	0.3 ATM	15 ATM	Lime or Gypsum	Cation Exchange Capacity (CEC)	Mechanical Analysis			Others
										% Clay	% Silt	% Sand	
													Texture
0.7	0	6.6	1.6	13.8		13.71	6.85			22.8	20.4	56.8	SCL
4.1	0	11.5	1.6	9.2		10.16	5.08			16.8	30.4	62.8	SCL
0.7	0	7.8	1.4	5.4		14.89	7.44			24.8	28.4	56.8	SCL
0.7	0	6.3	1.4	2.8		10.16	5.08			16.6	6.8	78.6	SL
43.4	0	6.0	1.2	5.2		7.85	3.92			12.8	5.4	81.8	LS
59.4	0	10.0	1.1	13.1		10.16	5.08			16.8	6.4	78.8	SL

Ind.-Obs. 2570 5000

Date Rec'd.

Date Sent

RESULTS OF
DEEP SOIL SAMPLE ANALYSIS

Montana Testing Laboratories,
P. O. Box 2013
Great Falls, Montana 59401

FOR: (Grower) Western Energy

CLIENT: (Dealer)

Area 11 Stop 18 Ca Cushman

Lab No.		Depth Inches	pH	Organic Matter %	Nitrate Nitrogen ppm	Lbs./Ac. N	Phosphorus P ppm	Potassium K ppm	Calcium Ca meq/100g	Magnesium Mg meq/100g	Sodium Na meq/100g	Salt Hazard mmhos	Soil Texture	
9005		0-6	7.6	1.6	10.4		29.5	150	27.5	3.2	0.1	0.5	L	M-
[illegible]		6-15	7.7	1.0	4.5		12.5	113	32.4	3.8	0.1	0.4	L	M+
9007		15-30	8.0	0.08	1.25		2.5	42	9.5	8.5	0.1	0.4	L-	M+
9008		30-58	8.2	0.08	2.5		7.7	63	30.7	11.7	0.1	0.3	FSL	M+
9009		58-72	7.9	0.2	4.5		5.0	275	8.8	5.0	0.1	0.8	L-	M+

OTHER TESTS REQUIRED

Sulfur ppm	Zinc ppm	Iron ppm	Copper ppm	Manganese ppm	Boron ppm	0.3 ATM	15 ATM	Lime or Gypsum	Cation Exchange Capacity (CEC)	Mechanical Analysis % Clay	% Silt	% Sand	Others
1.4	0	5.5	1.8	10.8		10.93	5.47			17.8	6.4	75.8	SL
0.7	0	3.2	1.4	4.4		11.45	5.72			18.8	40.4	40.8	L
2.8	0	5.2	1.4	3.6		14.8	7.4			24.8	32.4	42.8	L
80.3	0	6.6	1.4	2.8		13.71	6.83			22.8	46.4	30.8	L
+138	0.3	4.4	1.1	1.8		15.4	7.7			25.8	15.4	58.8	SCL

ELSO SERIES

The Elso Series consists of shallow, well-drained soils formed from weathered sandstone and siltstone. They occupy uplands and are underlain by sandstone and siltstone in depths of 6 to 20 inches. Annual precipitation is 10 to 14 inches.

In a representative profile the surface layer is light brownish-gray calcareous loam about 5 inches thick. Below this is a light gray loam about 6 inches thick that merges with soft sandstone and siltstone at a depth of about 11 inches. Slopes are 10 to 50 percent.

Permeability is moderate and moderately slow, and runoff is moderately rapid.

Typifying Pedon:

Typical profile of Elso loam:

A1-0-5 inches, light brownish-gray (2.5y 6/2) loam, grayish-brown (2.5y 5/2) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; weak effervescence; clear wavy boundary.

C1-5-11 inches, light-gray (2.5y 7/3) loam, light yellowish-brown (2.5y 6/3) moist; moderate medium platy structure; slightly hard, very friable, nonsticky and nonplastic; many fine and very fine pores; strong effervescence; clear wavy boundary.

C2-11-28 inches, white (2.5y 8/2) very soft platy siltstone that rubs to silt loam, light brownish-gray (2.5y 6/2) moist; few fine and very fine roots; strong effervescence.

Recommendations for Stockpiling:

All the soil material above the soft shale siltstone in the Elso loam part of this complex is suitable for stockpiling. The soil depth is approximately 1 foot, but locally can be less than 1 foot or nearly as much as 2 feet. The underlying soft shale and siltstone is undesirable for stockpiling because of slow rate of water intake.

Date Rec'd

Date Sent

RESULTS OF DEEP SOIL SAMPLE ANALYSIS

FROM:
Montana Testing Laboratories,
P. O. Box [illegible]
Great Falls, Montana 59403

FOR: (Grower) Western Energy
Area 11 Stop 15 Elso

CLIENT: (Dealer)

Lab No.	Your Field No.	Depth (Inches)	pH	Organic Matter %	Nitrate Nitrogen ppm	Lbs./Ac. N	Phosphorus P ppm	Potassium K ppm	Calcium Ca meq/100g	Magnesium Mg meq/100g	Sodium Na meq/100g	Salt Hazard mmhos	Soil Texture	[illegible]
9019		0-5	8.0	1.4	0.25		7.7	188	28.9	3.4	0.1	0.4	L	M
9020		5-11	8.2	1.2	1.25		[illegible]	[illegible]	28.[illegible]	3.2	0.1	0.4	L	M+
9021		11-20	8.1	1.1	0.5		33.5	113	24.5	5.0	0.3	0.7	VFSL	M+

OTHER TESTS REQUIRED

Sulfur ppm	Zinc ppm	Iron ppm	Copper ppm	Manganese ppm	Boron ppm	0.3 ATM	15 ATM	Lime or Gypsum	Cation Exchange Capacity (CEC)	Mechanical Analysis % Clay	% Silt	% Sand	Others
1.4	0	4.6	1.8	10.2		10.32	5.16			16.8	42.4	40.8	L
6.1	0	5.8	1.6	5.2		9.14	4.57			14.8	46.4	38.8	L
105	0	5.5	1.2	3.6		10.28	5.14			16.8	4.4	78.8	SL

B1-7

FORT COLLINS SERIES

The Fort Collins series consists of deep, well drained soils formed from alluvium washed from soft sandstone, loam and siltstone uplands. They occupy fans and footslopes. In a representative profile the surface layer is grayish brown loam about six inches thick. The subsoil is grayish brown to olive gray clay loam about 14 inches thick. Below this is calcareous olive and pale olive loam to 60 or more inches. Slopes are four to eight percent. The permeability is moderate and runoff is medium.

Typifying Pedon

Fort Collins Loam, Five Percent Slope

A_1 0-4 inches, graying brown (2.5Y 5/2) loam, very dark grayish brown (2.5Y 3/2) moist; moderate, very thin platy structure; hard, friable, slightly sticky and plastic; common fine and very fine roots; clear, smooth boundary.

B_1 4-6 inches, grayish brown (2.5Y 5/2) light clay loam, dark grayish brown (2.5Y 4.2) moist; moderate, coarse prismatic structure; hard, friable, sticky and plastic; common fine and very fine roots; clear, wavy boundary.

B_{2t} 6-14 inches, grayish brown (2.5Y 5/3) clay loam, olive brown (2.5Y 4/3) moist; moderate, medium and coarse prismatic structure parting to moderate, medium blocks; very hard, firm, very sticky and plastic; common fine and very fine roots; gradual, wavy boundary.

B_3 14-20 inches, pale olive (5Y 6/3) light clay loam, olive (5Y 5/3) moist; weak, medium prismatic structure parting to weak, medium blocks; very hard, firm, sticky and plastic; weak effervescence; a few fine lime mottles; a few very fine roots; clear, wavy boundary.

C_{1ca} 20-25 inches, pale yellow (5Y 7/3) light loam, pale olive (5Y 6/4) moist; massive; hard, friable, sticky and plastic; strong effervescence, common fine lime mottles; a few very fine roots; gradual, wavy boundary.

C_2 25-60 inches, pale olive (5Y 6/3) light loam, olive (5Y 5/4) moist; massive; hard, friable, slightly sticky and plastic; strong effervescence; a few fine lime mottles; a few very fine roots.

Location: 400' S and 85' W of ¼ corner, Sec. 8 & 9; T1N, R41E.

Laboratory Sample #5

Texture in the upper three feet ranges from light loam to heavy clay loam. At depths below three feet, stratification includes textures of silt loam and fine sandy loam.

Table 5 Chemical Properties of Horizon Samples Associated with Coal Areas
Western Energy Area B

Sample # 3 Fort Collins Loam

Lab No.	Horizon	Depth	pH Paste	Sat'n.	Elect. Cond.	Saturation Extract Cations Ca	Mg	Na	SAR
		inches		%	mmhos/cm	meq/liter			
7802	Ap	0-6	6.7	34.0	0.7	1.25	1.98	0.48	0.38
7803	B2t	6-16	7.1	40.5	0.8	2.13	2.08	0.69	0.48
7804	B3	16-21	7.8	38.2	0.5	1.63	2.29	1.00	0.68
7805	C1ca	21-27	8.1	37.1	1.1	2.50	8.96	2.30	0.99
7806	C2	27-62	8.1	33.3	0.5	1.88	3.13	1.30	0.83

Table 6 Results of Mechanical Analysis (Hydrometer Method) with Micro Nutrients (DTPA Zn, Fe, Cu, Mn) and Boron

Depth	Mechanical Analysis Clay	Silt	Sand	Texture	Zn	Fe	Cu	Mn	B
inches	%	%	%		ppm	ppm	ppm	ppm	ppm
0-6	17.2	13.2	69.6	SL	0.9	11.5	1.8	12.8	0.6
6-16	23.6	18.4	58.0	SL	0.02	8.4	1.6	6.7	0.5
16-21	28.4	20.8	50.8	SCL	0.2	8.4	1.6	6.7	0.3
21-27	21.2	21.6	57.2	SCL	0.04	4.6	1.6	1.8	0.7
27-62	14.8	12.0	73.2	SL	0.04	3.0	1.4	1.0	0.2

HAVERSON SERIES

The Haverson Series consists of deep, well-drained, calcareous soils formed in alluvium. They occupy flood plans along drainages and on fans. Slopes range from 0 to 8 percent. Annual precipitation is 10 to 14 inches.

In a representative profile, the surface layer is grayish-brown loam about 6 inches thick. The substratum is light brownish-gray and grayish-brown loam stratified with loamy fine sand.

Permeability is moderate and runoff is slow on the nearly level flood plains and medium on the fans.

Typifying Pedon:

Typical profile of Haverson loam:

Alp-0-6 inches, grayish-brown (2.5y 5/2) loam, dark grayish-brown (2.5y 4/2) moist; moderate fine crumb structure; slightly hard, very friable, nonsticky and slightly plastic; weak effervescence; abrupt wavy boundary.

A12-6-17 inches, grayish-brown (3.5y 5/2) silt loam, very dark grayish-brown (2.5y 4/2) moist; very weak fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; many fine and very fine pores; strong effervescence; clear smooth boundary.

C1-17-24 inches, grayish-brown (2.5y 5/2) loam, very dark grayish-brown (2.5y 3/2) when moist; massive; hard, friable, slightly sticky and slightly plastic; common fine and very fine pores; strong effervescence; few fine threads of lime; clear wavy boundary.

C2-24-52 inches, light brownish-gray (2.5y 6/3) loam, grayish-brown (2.5y 5/3) moist; massive; hard, very friable, nonsticky and slightly plastic; common very fine roots; many fine and very fine pores; strong effervescence; clear boundary.

C3-52-66 inches, light brownish-gray (2.5y 6/3) loamy fine sand, olive brown (2.5y 4/4) moist; massive; very friable, nonsticky and nonplastic; few fine and very fine roots; strong effervescence.

Haverson loam, 0 to 2 percent slopes (Hvg). This soil is found on nearly leveled flood plains along drainages. It has the typical profile for the series.
Risk of erosion is slight for water and moderate for wind.

Recommendations for Stockpiling:

This soil is suitable for stockpiling to a depth of at least 5 feet or below as deep as the underlying material remains basically the same. The water table at some depth greater than 5 feet generally occurs in this soil.

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Date Rec'd. 8-27-73

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RESULTS OF
DEEP SOIL SAMPLE ANALYSIS

FROM:
Montana Testing Laboratories, Inc.
P. O. Box 3048
Great Falls, Montana 59404

FOR: (Grower) Western Energy
AreaA1 Stop 8 Hvg

CLIENT: (Dealer)

Lab No.	Your Field No.	Depth (Inches)	pH	Organic Matter %	Nitrate Nitrogen ppm	Lbs./Ac. N	Phosphorus P ppm	Potassium K ppm	Calcium Ca meq/100g	Magnesium Mg meq/100g	Sodium Na meq/100g	Salt Hazards mmhos	Soil Texture	[illegible] X LIME
8726	36	0-6	7.9	1.3			4.3	275	18.1	3.0	0.1	0.4	L	S
8727	37	6-17	7.6	1.9			1.8	300	22.4	5.3	0.1	0.4	SiL+	S
8728	38	17-24	7.8	1.4			1.5	213	25.9	8.0	0.1	0.5	L+	S
8729	39	24-36	8.1	0.1			1.8	113	+35	13.1	0.1	0.4	L	M
8730	40	36-51	8.3	0.1			10.0	88	+35	12.6	0.1	0.6	L	M+
8731	41	51-6[illegible]	8.2	0.1			1.8	89	30.7	7.8	0.1	0.8	FSL	M

OTHER TESTS REQUIRED

TEXTURES

Sulfur ppm	Zinc ppm	Iron ppm	Copper ppm	Manganese ppm	Boron ppm	0.3 ATM	15 ATM	~~Lime or Gypsum~~ SAR	Cation Exchange Capacity (CEC)	Mechanical Analysis % Clay	% Silt	% Sand	~~[illegible]~~
42.9	0.1	10.6	2.8	4.8		5.66	2.83			8.8	26.4	64.8	SL
8.5	0.1	11.9	2.6	3.6		6.0	3.0			26.8	22.4	50.8	SCL
4.7	0.22	9.8	2.4	3.2		6.85	3.42			10.8	36.4	52.8	SL
68.2	0.45	19.0	2.6	10.2		14.92	7.46			24.8	12.4	62.8	SCL
70.1	0.22	18.0	2.9	5.4		9.12	4.56			14.8	20.4	64.8	SL
84.7	0.1	14.0	2.5	4.8		9.12	4.56			14.8	12.4	72.8	SL

HELDT SERIES

The Heldt Series consists of deep, well drained calcareous soils formed in alluvium. They occupy fans. Slopes range from two to eight percent. Annual precipitation is ten to 14 inches.

In a representative profile the surface layer is grayish-brown silty clay loam about six inches thick. The subsoil is light grayish brown silty clay loam about 16 inches thick. The underlying material is pale brown heavy loam or clay loam.

Permeability is slow and runoff is medium.

Typifying Pedon

Heldt silty clay loam, 2 to 8 percent slope:

A1 0-6 inches, dark grayish-brown (10yR 4/2) moist; silty clay loam; moderate fine granular structure; slightly hard when dry, friable when moist; and sticky when wet.

B2 6-22 inches, grayish-brown (10yR 5/2) moist; silty clay loam; coarse blocky structure; hard when dry, friable when moist; and sticky when wet; strong effervescence; small nodules and fine threads of segregated lime.

C1 22-34 inches, pale-brown (10yR 6/3) moist; heavy loam; massive; hard when dry, driable when moist and slightly sticky when moist; strong effervescence.

C2 34-44 inches, pale-brown (10yR 6/3) moist; heavy loam; massive; hard when dry; friable when moist and slightly sticky when wet; strong effervescence.

C3 44-60 inches; brown (10yR 5/3) moist; sandy loam; massive; slightly hard when dry, very friable when moist and nonsticky when wet; strong effervescence.

Date Rec'd. 8-29-73
Date Sent

RESULTS OF DEEP SOIL SAMPLE ANALYSIS

FROM:
Montana Testing Laboratories, Inc.
P. O. Box 2013
Great Falls, Montana 59401

FOR: (Grower) Western Energy
HELDT

CLIENT: (Dealer)

Lab No	Your Field No.	Depth (Inches)	pH	Organic Matter %	Nitrate Nitrogen ppm	Lbs./Ac. N	Phosphorus P ppm	Potassium K ppm	Calcium Ca meq/100g	Magnesium Mg meq/100g	Sodium Na meq/100g	Salt Hazards mmhos	Soil Texture	[illegible] LIME
9106		0-6	8.3	2.7	1.85	3.7	14.5	213	7.5	3.2	0.1	0.4	FSL	M
9107		6-22	8.4	1.2	0	0	62.0	88	19.4	3.0	0.1	0.3	L+	M+
9108		22-34	8.5	0.6	0	0	12.5	88	+35	7.3	0.1	0.5	SiL	M+
9109		34-44	8.6	0.08	0	0	12.5	62	29.3	9.2	0.1	0.9	L	M
9110		44-64	8.3	0.08	0	0	21.0	63	29.3	6.2	0.5	2.9	SiL	0

B1-14

OTHER TESTS REQUIRED

Sulfur ppm	Zinc ppm	Iron ppm	Copper ppm	Manganese ppm	Boron ppm	0.3 ATM	15 ATM	Lime or Gypsum SAR	Cation Exchange Capacity (CEC)	Mechanical Analysis % Clay	% Silt	% Sand	Other texture
	0.05	4.0	1.6	10.8		[illegible]	[illegible]	2.77		30.8	30.4	38.8	CL
	0	4.6	1.8	4.8		17.26	8.63	0.33		28.8	20.4	52.8	SCL
	0	5.2	2.0	3.6		19.5	9.75	0.32		32.8	26.4	40.8	CL
	0	7.0	1.6	2.8		13.38	9.19	1.22		30.8	24.4	44.8	SCL
	0	4.9	1.4	2.4		11.42	5.71	0.72		16.8	28.4	64.8	SL

MCRAE SERIES

The McRae series consists of deep, well drained nearly level to moderately sloping, calcareous soils on fans and terraces. These soils are formed in loamy alluvium. Annual precipitation is ten to 14 inches.

In a typical profile the surface layer and subsoil are light brownish-gray loam about 12 inches thick. The substratum is light gray loam and fine sandy loam. It is strongly calcareous and contains light gray masses of lime.

Permeability is moderate, and runoff is medium.

Typifying Pedon

McRae loam, 4 to 8 percent slopes:

Ap-0-6 inches, light brownish-gray (2.5y 6/2) loam, dark grayish-brown (2.5y 4.2) moist; moderate fine crumb structure; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; strong effervescence; abrupt wavy boundary.

B2-6-12 inches, light brownish-gray (2.5y 6/2) loam, olive brown (2.5y 4/4) moist; moderate medium prisms that separate to weak medium and fine subangular blocks; slightly hard, friable, slightly sticky and plastic; common fine and very fine and few medium roots; many fine and very fine pores; strong effervescence; clear wavy boundary.

B3ca-12-20 inches, pale-yellow (2.5y 7/3) loam, light olive-brown (2.5y 5/4) moist; weak coarse subangular blocks; hard, friable, slightly sticky and plastic; common fine and very fine roots; common fine and very fine pores; strong effervescence with common faint masses and threads of lime; diffused boundary.

Clca-20-24 inches, pale-yellow (2.5y 7/3) loam, light olive-brown (2.5y 5/4) moist; weak medium subangular blocky structure; hard, friable, sticky and plastic; common fine and very fine roots; many fine and very fine pores; strong effervescence; few faint masses and threads of lime; gradual boundary.

C2-24-60 inches, pale-yellow (2.5y 7/3) fine sandy loam, olive-brown (2.5y 4/4) moist; massive; slightly hard, very friable, slightly sticky and nonplastic; few fine and very fine roots; strong effervescence.

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Date Sent

RESULTS OF
DEEP SOIL SAMPLE ANALYSIS

Montana Testing Laboratories, In
P. O. Box 2013
Great Falls, Montana 59401

To: Western Energy
(Grower)
By McRae

CLIENT:
(Dealer)

[illegible]	Year Field No.	Depth Inches	pH	Organic Matter %	Nitrate Nitrogen ppm	Lbs./Ac. N	Phosphorus P ppm	Potassium K ppm	Calcium Ca meq/100g	Magnesium Mg meq/100g	Sodium Na meq/100g	Salt Hazards mmhos/cm	Soil Texture	Available H₂O (Inches)
135		0-6	7.9	2.9	22.95		17.5	213	20.3	5.3	0.1	0.6	SiCL-	LIME M-
36		6-16	8.2	0.9	7.5		5.0	88	+35	8.0	0.1	0.5	L	M+
37		16-24	8.3	0.1	1.85		5.0	63	+35	11.9	0.1	0.5	L+	M+
38		24-36												
39		36-66	9.0	0.1	0.25		21.0	2.5	34.1	8.0	1.0	0.6	L	M

OTHER TESTS REQUIRED

Sulfur ppm	Zinc ppm	Iron ppm	Copper ppm	Manganese ppm	Boron ppm	0.3 ATM	15 ATM	~~Lime or Gypsum~~ SAR	Cation Exchange Capacity (CEC)	Mechanical Analysis % Clay	% Silt	% Sand	Others Texture
38	0.05	3.0	1.6	4.8		10.57	5.29			30.8	50.4	18.8	SiCL
4.1	0	5.5	2.0	5.2		11.78	5.89			26.8	34.4	38.8	L
43.4	0.3	4.6	1.8	2.8		14.92	7.46			24.8	46.4	28.8	L
18.2	0	4.0	1.2	3.4		7.96	3.98			12.8	48.4	38.8	L

McRae loam, 0 to 2 percent slopes (Mc). This soil is found on nearly leveled terraces. The profile is typical for the series.
Risk of erosion is slight for both water and wind.

Recommendations for Stockpiling:

This soil is suitable for stockpiling to a depth of 5 feet. As indicated in maps, there are large areas of usable depths of 6 to 8 feet. Below the 8 foot depth unsuitable textures of clay loam or silty clay loam may be encountered along the main drainageways of the large fans.

McRae-Elso loams, 6 to 15 percent slopes (Mcc). This complex comprises moderately steep soils found on rolling uplands and fans. It is composed of about 60% McRae loam, 25% Elso loam and 15% Cushman soils. The McRae loam occupies the fans and lower footslopes, and the Elso loam occupies the ridges and knolls. The McRae and Elso soils in this complex are similar to the ones described as typical for the serieis, except that in some of the McRae loam the depth to soft shales and sandstones is between 40 and 60 inches.
Risk of erosion is severe for water and moderate for wind.

Recommendations for Stockpiling:

The McRae soil in this complex is suitable for stockpiling to a depth of 5 feet. Below this depth it is suitable only if the texture is not finer than silty clay loam.

The Elso soil is suitable stockpiling but has a depth range of 1 to 2 feet over the underlying soft shale and siltstone.

McRae loam, 15 to 35 percent slope (Mt). This mapping unit consists of eroded, disected edges of fans along drainageways, and the narrow floor of the drainageways. The unit follows the course of the drainageways and is seldom more than 200 feet wide. The slopes are short and steep on the sides of the drainageways and leveled on the bottom.
The soil profile differs from the normal McRae in that erosion has removed the upper leyers, and the subsoil below 20 inches is more variably stratified with textures of silt loam and fine sandy loam. Risk of erosion is severe for water and slight for wind.

Recommendations for Stockpiling:

The upper five feet of this soil is suitable for stockpiling. In the widest valleys the depth along the stream channel reaches up to 10 feet. The possibility of a water table below the 5 foot depth exists where sandstone bedrock or coal seams underlie the soil.

REMITT SERIES

The Remitt series consists of deep, well drained, moderately sloping and gently rolling soils on fans and footslopes. These soils are formed in sandy alluvium and aeolean sands. Annual precipitation is ten to 14 inches.

In a typical profile the surface layer and subsoil are grayish-brown fine sandy loams about 12 inches thick. The substratum is light yellowish brown, stongly calcareious fine sandy loam.

Permeability is moderately rapid, and runoff is slow.

Typifying Pedon

Remitt fine sandy loam, four to eight percent slopes:

Ap-0-6 inches, grayish-brown (2.5y 5/2) fine sandy loam, dark grayish-brown (2.5y 4.2) moist; weak fine crumb structure; soft when dry, very friable when moist; nonsticky and nonplastic when wet; weak effervescence; abrupt wavy boundary.

B2-6-12 inches, grayish-brown (10yR 5/2) fine sandy loam, dark brown (10yR 4/3) moist; weak coarse prismatic structure; soft when dry, very friable when moist; nonsticky and nonplastic when wet; common fine and very fine and few medium roots, common fine and very fine pores; strong effervescence; clear wavy boundary.

Clca-12-36 inches, light yellowish-brown (2.5y 6/3) fine sandy loam, light olive brown (2.5y 5/4) moist; massive; soft when dry, very friable when moist, nonsticky and nonplastic wet; common fine and very fine roots; common fine and very fine pores; strong effervescence and few fine, faint threads and masses of line; diffused boundary.

C2-36-60 inches, light yellowish-brown (2.5 6/3) fine sandy loam light olive brown (2.5y 5/4) when moist; massive; soft, very friable, nonsticky and nonplastic; few fine and very fine roots; strong effervescence.

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RESULTS OF DEEP SOIL SAMPLE ANALYSIS

From:
Montana Testing Laboratories, Inc.
P. O. Box 2013
Great Falls, Montana 59401

FOR: (Grower) Western Energy

REMITT

CLIENT: (Dealer)

Lab No.	Field No.	Depth (Inches)	pH	Organic Matter %	Nitrate Nitrogen ppm	Lbs./Ac. N	Phosphorus P ppm	Potassium K ppm	Calcium Ca meq/100g	Magnesium Mg meq/100g	Sodium Na meq/100g	Salt Hazards mmhos	Soil Texture	Available H2O (Inches)
9010		0-14	7.7	1.0	0.25		14.5	203	20.0	5.0	0.1	0.5	FSL+	0
9011		14-28	7.9	0.5	0.25		12.5	86	32.4	3.8	0.1	0.3	FSL	½
9012		28-50	7.9	0.08	0.25		17.5	43	34.1	7.1	0.1	0.4	FSL+	½
9013		50-72	8.2	0.08	0.25		7.7	2.5	21.5	7.3	0.1	0.4	FSL+	½+

63

B1-20

OTHER TESTS REQUIRED

Sulfur ppm	Zinc ppm	Iron ppm	Copper ppm	Manganese ppm	Boron ppm	0.3 ATM	15 ATM	Lime or Gypsum	Cation Exchange Capacity (CEC)	Mechanical Analysis % Clay	% Silt	% Sand	Others
3.4	0	7.0	2.3	10.0		11.8	5.9			26.8	34.4	38.8	L
0	0	4.9	1.4	5.2		9.06	4.53			14.8	30.4	54.8	SL
0	0	3.8	1.4	3.2		9.59	4.79			15.8	3.4	80.8	SL
0.7	0	3.0	1.1	1.4		9.59	4.79			15.8	2.4	81.8	SL

Remitt Fine Sandy Loam, Red Phase, 2 to 8 percent Slopes (Rc). This soil is found on gently and moderately sloping fans in replaced valleys. It differs from the profile described as typical for the series in being red.

Risk of erosion is slight for water and severe for wind.

Recommendations for Stockpiling:

The upper 5 feet of this soil is suitable for stockpiling. Locally, where the fans merge with the soils along major drainageways, the usable depth may reach up to 8 feet. The material below 2 feet, being low in organic matter and clay is easily wind eroded.

Shale Outcrop-Elso Complex, Very Steep (Sa). This complex is found on very steep broken slopes of the uplands. Elso loam is on ridges and knolls and on some of the steep side slopes. Loamy and clayey shale outcrops are mainly present on very steep slopes.

This complex is about 60% shale outcrop and about 30% Elso soil. The Elso soil has a typical profile for the series. About 10% of each mapped area consists of shallow clay and clay loam soils.

Risk of erosion is severe for water and moderate for wind.

Recommendations for Stockpiling:

None of this mixture of shallow soil material and raw shale is suitable for stockpiling. Slopes of more than 25% and the predominance of shale outcrops on the landscape make excavation difficult.

Red Rock Outcrop Complex Steep (Sb)

This complex comprises red rock outcrops and steep soils on uplands. About 60 percent is red rock outcrop and about 20 percent is Remitt fine sandy loam, red phase.

Included in mapping is about 20 percent soils that are 1- to 20 inches deep from red bedrock. The Remitt soil has a typical profile for the series, except that it is red in color.

Risk of erosion is moderate for water and wind.

None of this very shaley, channery and gravelly loam material is suitable for stockpiling. The isolated pockets of Remitt soils are so small, discontinuous, and of such steep slopes that they are impractical to excavate by conventional methods. Material coarser than three inches makes up to 30 to 75 percent of the volume of the identifiable soils in these areas.

THURLOW SERIES

The Thurlow series consists of deep, well drained, gently sloping to nearly level soils on terraces, fans, and footslopes. They formed in clayey alluvium washed from mixed shale and silt stone uplands.

In a typical profile the plowed layer is grayish brown heavy silt loam about five inches thick. The subsoil is grayish brown to light yellowish brown heavy silty clay loam, about 12 inches thick. The calcareous substratum is light yellowish brown to light gray silty clay loam to 60 or more inches.

Permeability is moderately slow, and runoff is medium to low.

Typifying Pedon

Thurlow Silty Clay Loam, one percent slope:

A_p 0-5 inches, grayish brown (2.5Y 5/2) heavy silt loam, very dark grayish brown (2.5Y 3/2) moist; massive; hard, friable, sticky and plastic; many fine and very fine roots; clear, smooth boundary.

B_1 5-8 inches, grayish brown (2.5Y 5/2) silty clay loam, very dark grayish brown (2.5Y 3/2) moist; moderate, medium prismatic structure; hard, firm, sticky and plastic; many fine and very fine roots; clear, smooth boundary.

B2t 8-12 inches, grayish brown (2.5Y 5/3) heavy silty clay loam, dark grayish brown (2.5Y 4.2) moist; moderate, medium prismatic structure parting to moderate, medium and fine blocks; very hard, firm, sticky and plastic; many fine and very fine roots; clear, wavy boundary.

B_3 12-17 inches, light yellowish brown (2.5Y 6/3) heavy silty clay loam, light olive brown (2.5Y 5/4) moist; moderate, medium prismatic structure parting to strong, fine blocks; very hard, firm, very sticky and plastic; common very fine roots; weak effervescence; gradual, wavy boundary.

C_{1ca} 17-24 inches, light yellowish brown (2.5Y 6/3) heavy silty clay loam, light olive brown (2.5Y 5/4) moist; weak, medium prismatic structure parting to weak, medium blocks; very hard, firm, very sticky and very plastic; strong effervescence; common very fine roots; gradual wavy boundary.

C_2 24-30 inches, light gray (2.5Y 7/3) silty clay loam, light yellowish brown (2.5Y 6/4) moist; weak, medium prismatic structure parting to weak, medium blocks; hard, firm, sticky and plastic; strong effervescence; common fine roots; clear wavy boundary.

Table 1 Chemical Properties of Horizon Samples Associated with Coal Areas
Western Energy Area B

Sample # 1 Thurlow Silty Clay Loam

Lab No.	Horizon	Depth inches	pH Paste.	Sat'd. %	Elect. Cond. mmhos/cm	Saturation Extract Cations Ca meq/liter	Mg meq/liter	Na+ meq/liter	SAR
7791	Ap	0-5	7.4	35.8	0.7	0.03	0.31	0.09	0.16
7792	B1	5-8	7.1	36.7	1.4	0.3	12.5	2.83	1.12
7793	B2t	8-12	7.4	40.3	0.8	2.31	4.5	0.91	0.49
7794	B3	12-17	8.1	45.6	1.6	3.75	11.3	3.01	1.32
7795	C1ca	17-24	8.4	51.5	11.4	2.25	165.0	40.4	4.42
7796	C2	24-30	8.5	48.1	12.6	0.45	184.0	45.7	4.76
7797	C3	30-65	8.6	34.8	16.0	0.65	263.0	64.7	5.63

Table 2 Results of Mechanical Analysis (Hydrometer Method) with Micro Nutrients (DTPA Zn, Fe, Cu, Mn) and Boron

Depth inches	Mechanical Analysis % Clay	% Silt	% Sand	Texture	Zn ppm	Fe ppm	Cu ppm	Mn ppm	B ppm
0-5	17.2	18.0	64.8	SL	1.1	9.2	1.4	8.9	1.1
5-8	25.2	8.4	66.4	SL	0.9	9.2	2.6	8.6	0.5
8-12	5.6	9.2	85.2	LS	0.1	8.0	1.8	1.2	0.5
12-17	36.8	20.8	42.4	L	0.03	4.4	1.6	1.2	0.7
17-24	2.0	64.8	33.2	SiL	0.2	6.0	2.0	1.0	1.0
24-30	1.2	68.8	30.0	SiL	0.2	5.8	1.4	1.2	1.4
30-65	2.8	33.6	63.6	SL	0.03	3.9	1.4	1.0	1.5

TULLOCK SERIES

The Tullock series consists of moderately deep, well to somewhat excessively drained, sloping to moderately steep soils on sandstone uplands.

In a typical profile the surface layer is grayish brown fine sandy loam, about four inches thick. The substratum is fine sandy loam to about 38 inches. The soil rests on sandstone at depths between 20 and 40 inches.

The permeability is moderately rapid and the runoff is low.

Typifying Pedon

Tullock Fine Sandy Loam, eight percent slope:

A_1 0-4 inches, grayish brown (10YR 5/2) fine sandy loam; very dark grayish brown (10YR 3/2) moist; weak, coarse crumb structure; slightly hard, very friable, nonsticky and slightly plastic; common fine and very fine roots; clear, smooth boundary.

B_1 4-9 inches, grayish brown (10YR 5/2) heavy sandy loam, very dark grayish brown (10YR 3/2) moist; moderate, coarse prismatic structure; hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; clear, wavy boundary.

C_1 9-21 inches, brown (10YR 5/3) light sandy loam, dark grayish brown (10YR 4/2) moist; weak, coarse prismatic structure, slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; clear, wavy boundary.

C_2 21-38 inches, light yellowish brown (2.5Y 6/3) light sandy loam, light olive brown (2.5Y 5/4) moist; massive; slightly hard, very friable, nonsticky and slightly plastic; weak effervescence; a few very fine roots; gradual, wavy boundary.

38+ inches, soft sandstone.

Location: 235' W and 25' No of ¼ corner, Sec. 7 & 8; T1N, R41E.

Laboratory Sample #2

Profile texture ranges from sandy loam to loamy fine sand. Content of coarse sandstone fragments ranges from zero to 30 percent.

Table 3 Chemical Properties of Horizon Samples Associated with Coal Areas
Western Energy Area B

Sample # 2 Tullock

Lab No.	Horizon	Depth inches	pH Paste	Sat'n. %	Elect. Cond. mmhos/cm	Saturation Extract Cations Ca meq/liter	Mg meq/liter	Na meq/liter	SAR
7798	A1	0-4	7.9	31.8	0.6	1.5	1.46	0.39	0.20
7799	B1	4-9	7.4	27.3	0.4	0.5	1.67	0.48	0.46
7800	C1	9-21	7.5	26.7	0.4	1.0	1.25	0.39	0.37
7801	C2	21-38	8.1	27.1	0.3	0.75	1.88	0.70	0.61

Table 4 Results of Mechanical Analysis (Hydrometer Method) with Micro Nutrients (DTPA Zn, Fe, Cu, Mn) and Boron

Depth inches	Mechanical Analysis Clay %	Silt %	Sand %	Texture	Zn ppm	Fe ppm	Cu ppm	Mn ppm	B ppm
0-4	11.2	6.4	82.4	SL	0.3	7.0	1.2	5.2	0.5
4-9	10.4	7.2	82.4	LS	0.04	5.5	1.0	4.0	0.4
9-21	11.6	10.8	77.6	SL	0.01	3.8	1.0	2.8	0.2
21-38	8.0	8.4	83.6	LS	0.04	2.4	1.4	1.4	0.5

APPENDIX B-2

OVERBURDEN ANALYSES - MINE AREAS A AND E

SOIL TOXICITIES

Chemical constituents of primary interest in the overburden are the concentrations of salts, sodium, and trace elements. The primary concern is to identify layers which are potentially toxic to plant growth or to animal consumption of plant material.

A salt hazard is normally considered to occur at an electrical conductivity (ECe) of 4 mmhos/cm in the saturation extract. At this level of salt concentration, the yield of salt sensitive plants is reduced. Conductivity levels are grouped by classes up to 16 mmhos/cm; in the highest only the most salt sensitive plants will grow.

High levels of sodium in soils have a significant detrimental effect on soil tilth. Sodium is a potentially toxic element at high concentrations, and may cause a deficiency in calcium uptake by plant tissue. However, sodium occurs most commonly at levels not detrimental to soil structure. At higher concentrations, soil structure breaks down, soil permeability is sharply decreased and cultivation is difficult. Sodium adsorption ratio (SAR) values of 10-12 or Exchangeable Sodium Percentage (ESP) values of 10-12 are indications of high sodium concentrations. These values are not directly applicable in terms of their effects on all soils because other factors such as absolute ion concentrations, soil texture, and clay mineral content affect soil structure as well.

GREAT FALLS • BILLINGS MONTANA • BOISE IDAHO • GILLETTE WYOMING

Report of: Analysis & Interpretations of Overburden
& Innerburden Samples Test Data
Western Energy Colstrip Mine

Date March 23, 1976
Job Number 69-147
Sheet 1 of 6

Report to: WESTERN ENERGY COMPANY (4)
ATTENTION MR MIKE GRENDE
40 EAST BROADWAY
BUTTE MT 59701

Sample Identification:

On December 8 & 22, 1975, and January 23, 1976, samples of overburden and innerburden were delivered to our laboratory for analysis and interpretation of the data. The results of the analyses were reported to you on January 9, 1976 and February 17 and 24, 1976. Copies of reports are enclosed.

TEST RESULTS:

The summary of the analysis is presented on the enclosed Tables. The narrative interpretation of the data was prepared by Dr. Vincent A. Haby, working with our staff, and he has approved the enclosed report.

cc: Dr. Vincent A. Haby
Southern Agricultural Research Center
Huntley, Montana 59037

Certified Leland J.

REPORT
OF
INTERPRETATION OF THE ANALYSIS OF OVERBURDEN & INNERBURDEN SAMPLES AS RELATED TO THE DISPOSAL OF STRIPPED MATERIALS AND REVEGETATION OF SURFACE MINED AREAS

WESTERN ENERGY COAL MINE, COLSTRIP, MONTANA

INTRODUCTION

The object of this investigation was to determine the levels of potentially toxic materials present in the overburden, and provide for the revegetation of the mined areas.

METHODS AND MATERIALS

Overburden and innerburden samples were collected and submitted by Western Energy Company to us for analysis. The procedures used for chemical and physical analysis are those recommended by the Department of State Lands in the tentative guidelines for the Montana Strip Mining and Reclamation Act. All data from the analyses are summarized on the enclosed Tables.

This interpretation includes a discussion of the analytical data, indicating drill holes and depths at which the data indicate a particular element exceeds levels acceptable for revegetation. A summary of the drill holes and depths at which unacceptable overburden material occurs, and another showing the acceptable materials, is included.

RESULTS AND DISCUSSION

This report includes two Tables, which point out critical and desirable chemical and physical properties of the 13 drill holes. Observation of test results at these 13 locations indicate that the pH, nitrate-nitrogen, boron, selenium, molybdenum, mercury, iron, manganese, and copper levels were lower than the suggested maximum limits set forth by the Montana Department of State Lands. Therefore, these elements have been omitted from Tables 1 and 2.

The purpose of Table 1 is to establish the location and depths at which overburden and innerburden materials contain suspect levels of chemical and/or physical properties (as established by the Montana Department of State Lands) which could interfere with revegetation of strip mined and regraded areas.

A conductivity level of 4.0 millimhos was used to differentiate between slightly saline and moderately saline conditions. However, since salinity affects plant growth by degree, and plants differ in their susceptibility to salts, deviations in conductivity up to 7 or 8 mmhos could possibly be tolerated if the proper plants are selected for revegetation.

Table 2 presents overburden soils which are the most suitable for revegetation of the mined and regraded areas. At all but three of the 13 drill holes, it is possible to use the surface soils, or a thorough mixture of the Rosebud overburden, for reclamation. Alternatives are suggested at these locations.

RECOMMENDATIONS

As noted in Table 1, zones in the Rosebud seam overburden contain potentially toxic chemical and/or physical properties, which, if not carefully considered during mining, could interfere with successful revegetation. The alternate recommendations below are offered for consideration. Each drill hole is treated independently, and care has been taken to provide feasible alternatives for the mixing or disposal of potentially toxic materials.

Should it become necessary to mine the McKay coal, it is recommended that the Rosebud-McKay innerburden be buried at the bottom of the pit, as this soil contains toxic, or nearly toxic, levels of several micronutrients in all the drill holes tested.

Drill Hole: N47000, E44000

The best overburden materials available to place under the topsoil are the intervals from 0 to 5 and 20 to 32 feet. However, if the overburden above the Rosebud seam is thoroughly mixed during the stripping process, the average composition of the mixture will fall below the levels considered suspect, and will be suitable for placement under the topsoil.

Drill Hole: N47000, E46000

The best overburden material available to place under the topsoil is the 0 to 15 foot depth. However, if the overburden above the Rosebud seam is thoroughly mixed during the stripping process, the average composition of the mixture will fall below the levels considered suspect, and will be suitable for placement under the topsoil.

Drill Hole: N49000, E44000

The best overburden materials available to place under the topsoil are the 0 to 7 and 64 to 74 foot depths. It may be impractical to separate out the 64 to 74 foot depth. If eight feet of non-toxic material must be left on the surface, it would be more practical to mix the soil from 0 to 8 feet. This would not increase the conductivity above the slightly saline level; however, if the overburden above the Rosebud seam is thoroughly mixed during the stripping process, the average composition of the mixture will fall below the levels considered suspect, and will be suitable for placement under the topsoil.

Drill Hole: N49000, E46000

The surface soil (0 to 3 feet) is not recommended for replacement on the surface due to high salt and sodium concentrations. The best overburden materials available to place under the topsoil are the 3 to 14 and 17 to 57 foot depths. However, if the salt and sodium concentrations are in the third foot, rather than in the 0 to 2 foot depth, the top two feet could be used for retopsoiling. Soil survey test results should be studied to make this determination. As in the above drill holes, if the overburden above the Rosebud seam is thoroughly mixed during the stripping process, the average composition of the mixture will fall below the levels considered suspect, and will be suitable for placement under the topsoil.

Drill Hole: N49000, E48000

The best overburden material available to place under the topsoil is the 0 to 20 foot depth. However, if the overburden above the Rosebud seam is thoroughly mixed during the stripping process, the average composition of the mixture will fall below the levels considered suspect, and will be suitable for placement under the topsoil.

Drill Hole: N49000, E50000

We suggest that the 0 to 3 foot interval be resampled and tested every foot to determine the extent of the high zinc concentration. If it is located in the 2 to 3 foot interval, it could be removed with the 4 to 7 foot depth, which also contains a high concentration of zinc. This might allow the 0 to 2 foot depth to be used as retopsoiling material. The texture of the 8 to 12 foot depth is a silty clay, and 12 to 15 feet is a silty clay loam. These two intervals can be mixed and placed under the topsoil without adverse affects.

Drill Hole: N49000, E52000

The best overburden material to place under the topsoil is the interval from 0 to 16 feet. However, if the overburden above the Rosebud seam is thoroughly mixed during the stripping process, the average composition of the mixture will fall below the levels considered suspect, and will be suitable for placement under the topsoil.

Drill Hole: N50000, E52000

The only materials which appear suitable for placement beneath the topsoil are the 20 to 22 and 26 to 29 foot depths. Mixing these two depths would also require a dilution of the salt concentration in the 20 to 22 foot depth, and the zinc concentration and clay content in the 26 to 29 foot depth. To obtain the eight feet of non-toxic material on the surface, you may consider bringing material from N49000, E52000 to this site.

Drill Hole: N51000, E48000

The best overburden materials available to place under the topsoil are the intervals from 20 to 30 and 35 to 40 feet. However, the salt content of the 0 to 10 and 10 to 20 foot depths is the only problem preventing these materials from being replaced on the surface. Conductivities of 4.55 and 5.45 are in the low end of the medium salinity category, and would probably not be a great hindrance to revegetation if placed below the topsoil surface. Resampling the 0 to 10 foot depth by one foot increments and analyzing for conductivity would be advisable to try to isolate the location of the salt concentration. The best alternative would be to thorougnly mix the overburden above the Rosebud seam during the stripping process. The average composition of the mixture will fall below the levels considered suspect, and will be suitable for placement under the topsoil.

Drill Hole: N52000, E47000

The best overburden material available to place under the topsoil is the interval from 130 to 150 feet. However, the interval from 0 to 20 feet has conductivities in the lower to medium end of the medium salinity category, and may be a suitable alternative for placement under the topsoil. These depths must be mixed thoroughly. Selection of plants with moderate salt tolerance should be considered for revegetation of this area.

Drill Hole: N53000, E48000

The best overburden material available to place under the topsoil is the 0 to 17 foot depth. However, if the overburden from 0 to 85 feet is thoroughly mixed during the stripping process, the average composition of the mixture will fall below the levels considered suspect, and will be suitable for placement under the topsoil.

Drill Hole: N55000, E48000

Adequate material for placement under the topsoil may be obtained in the depths from 0 to 8 feet. If additional soil material is necessary, it may be taken from the 24 to 29 foot depths.

Drill Hole: N54000, E47000

The 0 to 2 foot depth at this site is free from suspect levels of salt and heavy metals, and should be used as topsoil. If the 2 to 6 and 6 to 8 foot depths were mixed and placed below the 0 to 2 foot depth, revegetation could probably be accomplished.

NORTHERN TESTING LABORATORIES, INC.
CONSULTING SOILS ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

TABLE 1
WESTERN ENERGY COMPANY

Sheet 1 of 7
Job No. 69-147

Sample locations and depths of overburden and innerburden materials containing suspect levels of chemical and/or physica properties which could interfere with revegetation of coal strip mined and regraded areas.

Sample Location	Depth in Feet	Lab No.	Conductivity mmhos	SAR	Texture	Ammonium Nitrogen ppm	Zinc ppm	Cadmium ppm	Lead ppm	Nickel ppm
N47000	5 - 10	53953	4.2							
E44000	10 - 15	53954			Clay					
	15 - 20	53955			Silty Clay					1.49
	32 - 35	53958								2.76
	35 - 45	53959								2.48
	45 - 55	53960								2.01
	120 - 130	53968								1.21
	130 - 140	53969								1.01
	140 - 150	53970			Clay		46.9 Bury			1.80
	150 - 155	53971			Clay		33.2			1.61
1B	176 - 180	53972			Clay					2.31
	180 - 190	53973					127.0			1.62
	190 - 200	53974					47.1			1.20
	200 - 210	53975					441.0	0.19		
	220 - 230	53976					459.0	0.17		
	230 - 235	53977					300.0	0.15		
N47000	15 - 23	53924					111.0 Bury			
E46000	23 - 32	53925								2.30
1B	53 - 60	53926								1.42
	60 - 70	53927					459.0	0.19		
	80 - 90	53929					300.0	0.14		
	90 - 100	53930					153.0			
	100 - 110	53931					102.0			
	110 - 113	53932					75.8			

TABLE 1
WESTERN ENERGY COMPANY

Sample Location	Depth In Feet	Lab No.	Conductivity mmhos	SAR	Texture	Ammonium Nitrogen ppm	Zinc ppm	Cadmium ppm	Lead ppm	Nickel ppm
N49000	7 - 17	54066	7.36							
E44000	17 - 20	54067	5.42		Clay					
	20 - 30	54068			Clay					
	30 - 34	54069								1.26
	34 - 44	54070					29.9			1.55
	44 - 54	54071			Clay					1.39
	54 - 64	54072								1.36
	74 - 84	54074					49.7 Bury			
	95 - 100	54076								1.75
	100 - 109	54077								1.29
	109 - 118	54078			Silty Clay					1.03
	128 - 138	54080						0.11		1.35
IB	158 - 160	54081			Silty Clay					1.36
	170 - 180	54083					240.0	0.20		
	180 - 190	54084					678.0	0.35		
	190 - 200	54085					576.0	0.36		
	200 - 210	54086					642.0	0.35		
	210 - 220	54087					492.0	0.28		
N49000	0 - 3	53933	9.19	11.75	– retest					
E46000	14 - 17	53935						0.35		
	64 - 67	53941			Clay					1.92
	67 - 77	53942								2.51
	77 - 87	53943								2.47
	87 - 97	53944			Clay					1.51

NORTHERN TESTING LABORATORIES, INC.
CONSULTING SOILS ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

Sheet 3 of 7
Job No. 69-147

TABLE 1
WESTERN ENERGY COMPANY

Sample Location	Depth in Feet	Lab No.	Conductivity mmhos	SAR	Texture	Ammonium Nitrogen ppm	Zinc ppm	Cadmium ppm	Lead ppm	Nickel ppm
IB	106 - 116	53945					93.0			1.00
	120 - 130	53946					522.0	0.20		
	130 - 140	53947					612.0	0.20		
	140 - 150	53948					585.0	0.19		
	150 - 160	53949					83.0			
	160 - 170	53950					342.0	0.22		
	170 - 176	53951					185.0	0.11		
N49000	8 - 11	54046			Silty Clay					
E48000	20 - 27	54050			Silty Clay					1.43
	38 - 40	54052			Silty Clay					1.62
	46 - 53	54054					34.2			
	56 - 66	54056					77.2 – Gary			1.75
IB	104 - 108	54058					129.0	0.12		
	116 - 126	54059					216.0	0.13		
	126 - 136	54060					53.9			
	136 - 146	54061					135.0			
	146 - 156	54062					42.3			
	156 - 165	54063					38.4			
N49000	0 - 3	53885					85.0 – contaminated sample			
E50000	3 - 8	53886	9.95 – [illegible]				154.0	0.11		
	8 - 12	53887			Silty Clay					
	15 - 20	53889			Clay					
	20 - 25	53890			Clay					

NORTHERN TESTING LABORATORIES, INC.
CONSULTING SOILS ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

Sheet 4 of 7
Job No. 69-147

TABLE 1
WESTERN ENERGY COMPANY

Sample Location	Depth in Feet	Lab No.	Conductivity mmhos	SAR	Texture	Ammonium Nitrogen ppm	Zinc ppm	Cadmium ppm	Lead ppm	Nickel ppm
1B	55 - 60	53892					387.0	0.24		
	60 - 70	53893					241.0	0.14		
	70 - 80	53894					34.9			
	80 - 90	53895					156.0			
	90 - 97	53896					152.0			1.00
	97 - 100	53897					199.0	0.11		1.25
N49000 E52000	26 - 36	53907					84.5	Query		1.17
1B	58 - 68	53909			Clay		139.0	0.10		1.43
	68 - 75	53909					138.0			1.11
	75 - 80	53910					94.0			
	80 - 85	53911					350.0	0.19		1.32
N50000 E52000	0 - 10	53912					173.0 - probably contamination			
	10 - 16	53913	8.40	9.35						
	16 - 20	53914	10.2	11.39						
	20 - 22	53915	5.75							
	22 - 26	53916					378.0	Query 0.22		
	26 - 29	53917			Clay		53.2			
1B	51 - 61	53918					48.9			1.15
	61 - 71	53919								1.01
	71 - 76	53920					47.6			1.89

NORTHERN TESTING LABORATORIES, INC.
CONSULTING SOILS ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

TABLE 1
WESTERN ENERGY COMPANY

Sheet 5 of 7
Job No. 69-147

Sample Location	Depth in Feet	Lab No.	Conductivity mmhos	SAR	Texture	Ammonium Nitrogen ppn.	Zinc ppm	Cadmium ppm	Lead ppm	Nickel ppm
N51000	0 - 10	52529	5.45							
E48000	10 - 20	52530	4.55							
	30 - 35	52532			Silty Clay					
	40 - 45	52534								1.66
	80 - 90	52539								1.38
	90 - 100	52540								1.35
IB	160 - 170	52543								1.33
N52000	0 - 5	52510	6.20							
E47000	5 - 10	52511	8.50							
	10 - 15	52512	5.30							
	15 - 20	52513	6.50		Clay					
	20 - 30	52514		15.34	Silty Clay					1.29
	30 - 35	52515		24.13	Silty Clay	29.4				1.85
	35 - 40	52516		28.85		31.9				2.04
	40 - 50	52517		29.37		32.6				1.87
	50 - 60	52518		27.72		37.8				1.68
	60 - 63	52519	4.95	23.99	Clay	25.4				2.62
	63 - 70	52520		29.59	Silty Clay	32.2				
	70 - 80	52521		31.27						
	80 - 90	52522	5.10	49.86	Silty Clay					
	90 - 100	52523		16.65						1.34
	100 - 110	52524		15.76	Silty Clay	26.9				
	110 - 120	52525		16.49						
	120 - 130	52526		13.83						
IB	185 - 195	52956								1.06
	205 - 215	52958								2.92
	225 - 235	52960								1.26

Bury

TABLE 1
WESTERN ENERGY COMPANY

Sheet 6 of 7
Job No. 69-147

Sample Location	Depth in Feet	Lab No.	Conductivity mmhos	SAR	Texture	Ammonium Nitrogen ppm	Zinc ppm	Cadmium ppm	Lead ppm	Nickel ppm
N53000	0 - 5	52885	5.50							
E48000	5 - 10	52886	5.10							
	17 - 19	52889			Silty Clay					
	19 - 21	52890			Silty Clay					
	26 - 28	52892			Clay				18.6	1.88
	32 - 35	52894				67.5				
	35 - 45	52895			Silty Clay					2.15
	45 - 55	52896								1.65
	55 - 65	52897								1.28
	65 - 75	52898								1.41
	75 - 85	52899								1.57
	85 - 92	52900	4.50		Clay	31.5				5.65 [illegible]
1B	117 - 127	52901								1.58
	157 - 162	52905								1.37
N55000	8 - 13	52907	8.75	12.28						
E48000	13 - 17	52908	8.00	11.72						
	17 - 24	52909	5.30	11.07						
	24 - 29	52910	4.30							1.00
	29 - 32	52911		12.87						
	32 - 35	52912		10.17	Clay					1.17
	35 - 42	52913		11.25						
	42 - 45	52914		10.54						
	45 - 47	52915		10.77						
	47 - 51	52916		11.89	Clay					1.75
	51 - 55	52917		17.62						
	55 - 57	52918	4.60		Silty Clay					1.80
	57 - 64	52919		25.11						
	64 - 74	52920		23.14						1.41

NORTHERN TESTING LABORATORIES, INC.
CONSULTING SOILS ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

TABLE 1
WESTERN ENERGY COMPANY

Sheet 7 of 7
Job No. 69-147

Sample Location	Depth in Feet	Lab No.	Conductivity mmhos	SAR	Texture	Ammonium Nitrogen ppm	Zinc ppm	Cadmium ppm	Lead ppm	Nickel ppm
IB	105 - 110	52912		17.38	Silty Clay					
	110 - 120	52922		11.13						1.24
	120 - 130	52923		12.77						
N54000	2 - 6	52928	7.10		Clay					
E47000	6 - 8	52929	7.00							
	8 - 11	52930	6.40		Silty Clay					
	11 - 14	52931	6.25							
	14 - 17	52932	6.50							
	17 - 19	52933	5.95							
	19 - 21	52934	4.50	10.05						
	21 - 27	52935	4.60	12.34						
	27 - 31	52936	6.50	12.27	Silty Clay		Bung			
	31 - 36	52937		23.89	Silty Clay	32.9				1.62
	36 - 46	52938		25.23	Silty Clay	38.3				2.47
	46 - 56	52939		29.93	Silty Clay	44.4				2.76
	56 - 66	52940		36.14		30.1				1.60
	66 - 76	52941	6.80	20.58	Clay	26.9				2.44
	76 - 86	52942		20.58						1.10
	86 - 96	52943		35.33	Silty Clay				15.5	
	96 - 106	52944		31.29		25.4				1.11
	106 - 116	52945		29.24	Silty Clay					0.98
	116 - 126	52946		25.89		26.9				1.04
	126 - 136	52947		18.45		25.1				1.47
	136 - 146	52948		20.24						1.13
	146 - 156	52949		18.33	Silty Clay					2.52
	156 - 159	52950	5.40	14.33		31.5		0.23		2.03
IB	183 - 190	52951								1.10

NORTHERN TESTING LABORATORIES, INC.
CONSULTING SOILS ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

TABLE 2
WESTERN ENERGY COMPANY

Sheet 1 of 2
Job No. 69-147

Sample locations and depths of overburden soil materials which appear to be most suitable for revegetation of coal strip mined and regraded areas.

Sample Location	Depth in Feet	Lab No.	Conductivity mmhos	SAR	Texture	Ammonium Nitrogen ppm	Zinc ppm	Cadmium ppm	Lead ppm	Nickel ppm
N47000	0 - 5	53952	3.68	2.11	Silt Loam	5.3	4.61	-0.01*	0.8	0.35
E44000	20 - 29	53956	2.02	1.90	Loam	14.8	3.83	0.02	1.2	0.83
	29 - 32	53957	1.99	1.95	Loam	8.4	2.35	0.01	0.6	0.79
N47000	0 - 2	53921	0.50	0.14	Loam	5.9	9.85	0.02	0.9	0.06
E46000	2 - 5	53922	0.23	0.09	Loam	7.0	0.49	-0.01	0.7	0.09
	5 - 15	53923	0.32	0.29	Sandy Loam	5.0	0.63	-0.01	0.6	0.08
N49000	0 - 3	54064	0.38	0.24	Sandy Loam	3.6	5.85	0.03	0.7	0.18
E44000	3 - 7	54065	3.71	5.98	Sandy Clay Loam	3.4	1.43	0.03	0.6	0.17
	64 - 74	54073	1.38	4.06	Sandy Loam	4.5	1.79	0.04	1.1	0.35
N49000	3 - 14	53934	2.99	6.60	Sandy Loam	7.0	1.53	0.01	0.3	0.18
E46000	17 - 21	53936	2.29	5.82	Sandy Loam	4.5	15.9	0.01	0.3	0.24
	21 - 31	53937	2.28	5.04	Sandy Loam	6.7	2.56	0.01	0.5	0.26
	31 - 47	53938	2.67	4.42	Sandy Loam	5.0	6.82	-0.01	0.6	0.29
	47 - 57	53939	2.16	3.91	Loamy Sand	14.8	3.89	0.01	0.6	0.31
N49000	0 - 1	54043	0.59	0 24	Sandy Loam	10.1	22.4	0.05	0.8	0.37
E48000	1 - 4	54044	0.51	0.85	Clay Loam	4.2	9.37	0.02	0.6	0.15
	4 - 8	54045	1.01	1.60	Silty Clay Loam	5.6	14.3	0.02	1.4	0.12
	11 - 16	54047	0.74	0.77	Silty Clay Loam	6.2	2.94	0.04	1.2	0.12
	16 - 18	54048	0.73	0.63	Silty Clay Loam	10.9	1.70	0.01	3.4	0.47
	18 - 20	54049	0.77	0.58	Silt Loam	16.0	0.79	0.04	0.8	0.12

5 - 18-6 ft.
7 - 12 [illegible]
[illegible] for Cond + SAR.

*Minus sign indicates concentration is less than value shown.

TABLE 2
WESTERN ENERGY COMPANY

Sheet 2 of 2
Job No. 69-147

Sample Location	Depth in Feet	Lab No.	Conductivity mmhos	SAR	Texture	Ammonium Nitrogen ppm	Zinc ppm	Cadmium ppm	Lead ppm	Nickel ppm
N49000 E50000	0 - 3	53885	0.35	0.25	Loam	10.9	85.07	0.07	0.7	0.30
	12 - 15	53888	2.06	0.45	Silty Clay Loam	7.3	1.64	0.02	1.1	0.25
N49000 E52000	0 - 2	53898	0.38	0.34	Sandy Loam	6.4	2.31	-0.01	0.4	0.09
	2 - 5	53899	0.91	3.51	Loam	7.6	1.32	-0.01	0.4	0.07
	5 - 9	53900	3.10	3.12	Silt Loam	8.1	4.14	-0.01	0.5	0.04
	9 - 12	53901	3.60	1.39	Sandy Loam	7.0	0.59	-0.01	0.7	0.05
	12 - 16	93302	0.45	0.77	Silty Clay Loam	6.7	1.48	-0.01	1.1	0.03
N50000 E52000	20 - 22	53915	5.75	5.08	Sandy Loam	6.2	2.26	-0.01	0.5	0.05
	26 - 29	53917	1.70	0.91	Clay	12.6	53.2	0.04	2.0	-0.01
N51000 E48000	20 - 30	52531	3.15	2.10	Clay Loam	16.1	14.4	-0.01	1.20	0.16
	35 - 40	52533	2.80	1.35	Clay Loam	19.7	5.72	0.01	2.96	0.98
N52000 E47000	0 - 5	52510	6.20	5.25	Silty Loam	22.9	10.2	0.03	1.3	0.19
	10 - 15	52512	5.30	8.89	Silt Loam	15.4	2.92	-0.01	0.9	0.03
	130 - 140	52527	1.95	8.86	Sandy Loam	15.0	2.39	-0.01	0.7	0.89
	140 - 150	52528	1.55	6.84	Loamy Sand	16.5	3.27	-0.01	1.1	0.84
N53000 E48000	0 - 5	52885	5.50	4.18	Silt Loam	13.2	1.86	0.02	0.7	-0.01
	5 - 10	52886	5.10	4.90	Silty Clay Loam	14.7	1.92	0.03	1.4	-0.01
	10 - 15	52887	3.70	4.24	Clay Loam	15.4	0.90	0.01	2.3	0.09
	15 - 17	52888	3.50	4.97	Silty Clay Loam	19.0	1.74	0.01	2.1	0.04
N55000 E48000	0 - 8	52906	0.65	6.28	Sandy Clay Loam	18.6	2.58	0.04	1.3	0.33
	24 - 29	52910	4.30	8.55	Silty Clay Loam	20.8	1.93	0.05	6.0	1.00
N54000 E47000	0 - 2	52927	2.35	0.14	Silt Loam	24.7	8.35	0.03	0.6	0.14
	2 - 6	52928	7.10	5.95	Clay	15.8	1.52	0.07	3.1	0.67
	6 - 8	52929	7.00	6.91	Silt Loam	23.6	3.15	0.03	1.6	0.04

NORTHERN TESTING LABORATORIES, INC.
CONSULTING GEOTECHNICAL ENGINEERS
Great Falls Billings, Montana - Boise, Idaho - Gillette, Wyoming

REVISED: March 23, 1976
February 17, 1976
Job No. 69-147

CHEMICAL ANALYSIS OF TOPSOIL AND OVERBURDEN
AREA A, SECTION 5
N47000-E44000
WESTERN ENERGY COMPANY - COLSTRIP, MONTANA

B2-18

Depth, Feet	Lab No.	pH	Conductivity mmhos/cm	Saturation %	Calcium meq/ Liter	Calcium meq/ 100 grams*	Magnesium meq/Liter	Magnesium meq/ 100 grams*	Sodium meq/ Liter	Sodium meq/ 100 grams*	SAR	Texture**	Probable Subsurface Formation
0 - 5	53552	8.0	3.68	43.7	11.8	0.52	34.2	1.51	10.1	0.44	2.11	Silt Loam	Brown Topsoil
5 - 10	53553	7.7	4.20	54.0	24.1	1.30	35.9	1.94	7.70	0.42	1.41	Silt Loam	Brown Topsoil
10 - 15	53554	7.7	3.90	72.6	23.8	1.74	32.2	2.35	7.01	0.51	1.33	Clay	Brown Clay
15 - 20	53555	7.8	3.01	65.2	15.1	0.98	21.2	1.38	6.26	0.41	1.47	Silty Clay	Brown Clay
20 - 29	53556	7.8	2.02	49.8	7.46	0.37	11.9	0.60	5.90	0.30	1.90	Loam	Brown Sandy Shale
29 - 32	53557	7.7	1.99	44.5	8.12	0.37	11.0	0.50	6.03	0.27	1.95	Loam	Brown Sandy Shale
32 - 35	53558	7.9	1.58	67.6	5.82	0.40	7.89	0.54	5.06	0.34	1.93	Silty Clay Loam	Gray Shale
35 - 45	53559	7.9	1.74	53.3	6.40	0.34	9.34	0.50	5.49	0.29	1.96	Loam	Gray Shale
45 - 55	53560	7.9	2.00	48.4	6.70	0.32	13.1	0.63	5.55	0.27	1.76	Loam	Gray Sandy Shale
55 - 60	53561	7.9	1.55	44.2	4.72	0.21	9.86	0.43	4.82	0.21	1.79	Loam	Brown Sandy Shale
60 - 70	53562	8.0	0.74	27.2	2.74	0.07	4.15	0.11	1.90	0.05	1.02	Sandy Loam	Brown Sandstone
70 - 80	53563	8.0	1.17	28.6	3.84	0.11	6.99	0.20	3.08	0.09	1.32	Loamy Sand	Brown Sandstone
80 - 90	53564	8.0	2.18	25.0	14.6	0.37	15.8	0.40	1.70	0.04	0.44	Loamy Sand	Brown Sandstone
90 - 100	53565	7.7	3.60	26.0	28.1	0.73	25.2	0.66	2.18	0.06	0.42	Sandy Loam	Brown Sandstone
100 - 110	53566	8.0	0.96	27.7	3.05	0.09	6.83	0.19	1.63	0.05	0.73	Loamy Sand	Brown Sandstone
110 - 120	53567	7.8	1.18	25.2	3.88	0.10	7.39	0.19	2.05	0.05	0.86	Sandy Loam	Brown Sandstone
120 - 130	53568	7.8	2.20	24.2	12.4	0.30	14.8	0.36	2.80	0.07	0.76	Loamy Sand	Gray Sandstone
130 - 140	53569	7.6	1.70	24.8	8.78	0.22	10.0	0.25	3.35	0.08	1.09	Sandy Loam	Gray Sandstone
140 - 150	53570	7.8	1.30	52.3	7.24	0.38	8.57	0.45	2.68	0.14	0.95	Clay	Gray Shale
150 - 155	53571	7.3	1.20	54.0	4.15	0.22	7.18	0.39	2.78	0.15	1.17	Clay	Dark Gray Shale
155 - 180 I.B.	53572	6.9	2.40	53.4	9.00	0.48	15.1	0.80	3.50	0.19	1.01	Clay	Dark Gray Clay
180 - 190 I.B.	53573	7.2	2.21	41.5	7.83	0.33	14.2	0.60	3.49	0.15	1.05	Clay Loam	Dk. Gray Sandy Shale
190 - 200 I.B.	53574	7.6	1.37	30.3	5.61	0.17	10.7	0.32	4.48	0.13	1.57	Sandy Loam	Dark Gray Sandstone
200 - 210 I.B.	53575	7.9	3.01	23.1	11.6	0.27	15.0	0.37	7.18	0.17	1.93	Sandy Loam	Gray Sandstone
210 - 230 I.B.	53576	8.0	1.94	21.0	9.14	0.19	9.14	0.19	4.52	0.10	1.50	Sandy Loam	Gray Sandstone
230 - 235 I.B.	53577	7.9	1.13	22.4	4.45	0.10	5.09	0.11	2.45	0.05	1.12	Loamy Sand	Gray Sandstone

*Oven Dry Soil **U. S. Department of Agriculture Soil Textural Triangle

NORTHERN TESTING LABORATORIES, INC.
CONSULTING GEOTECHNICAL ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

ANALYSIS OF TRACE ELEMENTS IN OVERBURDEN
AREA A, SECTION 5
WESTERN ENERGY COMPANY - COLSTRIP, MONTANA

February 17, 1976
Job No. 69-147

All in Parts Per Million (-) Indicates Less Than Given Value

Sample Location	Depth, Ft.	Lab No.	Nitrate Nitrogen	Ammonia Nitrogen	Boron	Selenium	Molybdenum	Mercury	Zinc	Iron	Manganese	Copper	Cadmium	Lead	Nickel
N47000- E44000	0 - 5	53952	-0.01	5.3	0.37	-0.02	0.26	0.053	4.61	12.5	3.80	0.58	-0.01	0.8	0.35
	5 - 10	53953	-0.01	13.4	0.41	-0.02	0.30	0.063	1.72	20.5	4.28	1.04	0.02	1.6	0.48
	10 - 15	53954	-0.01	19.9	0.45	-0.02	0.20	0.118	1.65	36.0	7.90	2.54	0.05	1.7	0.77
	15 - 20	53955	-0.01	20.7	0.26	-0.02	0.28	0.130	4.01	57.9	11.9	3.38	0.04	2.2	1.49
	20 - 29	53956	-0.01	14.8	0.04	-0.02	0.45	0.074	3.83	23.6	5.56	0.95	0.02	1.2	0.83
	29 - 32	53957	-0.01	8.4	0.33	-0.02	0.39	0.084	2.35	16.9	3.23	0.64	0.01	0.6	0.79
	32 - 35	53958	-0.01	21.8	0.45	-0.02	0.37	0.112	5.08	72.9	10.6	3.51	0.03	3.8	2.76
	35 - 45	53959	-0.01	17.6	0.42	-0.02	0.54	0.049	10.2	60.1	3.83	1.85	0.02	3.1	2.43
	45 - 55	53960	-0.01	10.6	0.37	-0.02	0.50	0.101	4.77	49.9	5.03	1.33	0.02	2.5	2.01
	55 - 60	53961	-0.01	7.3	0.33	-0.02	0.39	0.071	1.35	12.6	2.38	0.62	-0.01	0.7	0.53
	60 - 70	53962	-0.01	4.8	1.15	-0.02	0.20	0.045	0.89	6.7	1.90	0.21	-0.01	0.2	0.30
	70 - 80	53963	-0.01	7.0	0.30	-0.02	-0.20	0.055	0.90	7.2	1.41	0.20	-0.01	0.2	0.27
	80 - 90	53964	0.17	5.0	0.22	-0.02	-0.20	0.036	3.19	10.5	1.39	0.21	-0.01	0.5	0.26
	90 - 100	53965	0.83	6.7	0.37	-0.02	0.34	0.055	3.80	12.2	1.25	0.36	-0.01	0.4	0.40
	100 - 110	53966	-0.01	3.6	0.30	-0.02	0.30	0.039	3.21	9.1	1.65	0.35	-0.01	0.5	0.29
	110 - 120	53967	0.22	3.6	0.41	-0.02	0.32	0.063	3.68	18.8	2.14	0.75	-0.01	0.6	0.45
	120 - 130	53968	-0.01	5.3	0.49	-0.02	0.40	0.099	6.75	30.2	2.22	0.68	-0.01	0.8	1.21
	130 - 140	53969	-0.01	6.2	0.19	-0.02	0.48	0.059	4.16	51.3	2.54	0.44	-0.01	1.2	1.01
	140 - 150	53970	-0.01	10.9	0.60	-0.02	0.30	0.175	46.9	47.7	0.99	6.65	0.04	3.7	1.80
	150 - 155	53971	-0.01	10.6	1.64	-0.02	0.34	0.192	33.2	81.5	2.20	3.40	0.06	6.2	1.61
1.B.	175 - 180	53972	-0.01	16.2	2.94	-0.02	0.36	0.318	21.0	55.6	3.09	4.42	0.06	7.8	2.31
1.B.	180 - 190	53973	-0.01	11.8	2.57	-0.02	0.28	0.383	127.0	73.0	4.48	2.65	0.09	3.5	1.62
1.B.	190 - 200	53974	-0.01	4.2	1.34	-0.02	0.46	0.293	47.1	55.8	3.31	0.93	0.03	2.1	1.22
1.B.	200 - 210	53975	-0.01	6.7	1.03	-0.02	0.30	0.148	441.0	4.9	1.52	0.19	0.19	0.1	0.74
1.B.	220 - 230	53976	-0.01	5.9	1.04	-0.02	-0.20	0.089	459.0	6.4	1.78	0.16	0.17	0.1	0.73
1.B.	230 - 235	53977	-0.01	4.5	0.56	-0.02	-0.20	0.105	300.0	25.1	3.75	0.41	0.15	1.0	0.69

NORTHERN TESTING LABORATORIES, INC.
CONSULTING GEOTECHNICAL ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

CHEMICAL ANALYSIS OF TOPSOIL AND OVERBURDEN
AREA A, SECTION 5
N47000-E46000
WESTERN ENERGY COMPANY - COLSTRIP, MONTANA

February 17, 1976
Job No. 69-147

Depth, Feet	Lab No.	pH	Conductivity mmhos/cm	Saturation %	Calcium meq/Liter	Calcium meq/100 grams*	Magnesium meq/Liter	Magnesium meq/100 grams*	Sodium meq/liter	Sodium meq/100 grams*	SAR	Texture**	Probable Subsurfa Formation
0 - 2	53921	7.7	0.50	33.5	5.00	0.17	1.75	0.06	0.26	0.01	0.14	Loam	Brown Topsoil
2 - 5	53922	7.9	0.23	31.5	1.94	0.06	1.30	0.04	0.12	-0.01	0.09	Loam	Brown Topsoil
5 - 15	53923	8.1	0.32	27.9	1.11	0.03	2.78	0.08	0.40	0.01	0.29	Sandy Loam	Brown Sandstone
15 - 23	53924	7.7	0.72	60.1	1.20	0.07	3.70	0.22	2.82	0.17	1.80	Silty Clay Loam	Brown Shale
23 - 32	53925	5.0	1.45	56.1	5.15	0.29	6.48	0.36	5.96	0.33	2.47	Clay Loam	Gray Sandy Shale
53 - 60 I.B.	53926	6.9	2.94	46.1	16.8	0.77	18.2	0.84	6.80	0.31	1.63	Clay Loam	Gray Shale
60 - 70 I.B.	53927	7.2	2.46	33.6	12.7	0.43	14.1	0.47	5.72	0.19	1.56	Sandy Loam	Gray Sandstone
70 - 80 I.B.	53928	7.1	1.75	27.9	8.01	0.22	8.22	0.23	4.32	0.12	1.52	Sand	Gray Sandstone
80 - 90 I.B.	53929	7.3	2.50	28.3	9.90	0.28	12.8	0.36	5.94	0.17	1.76	Loamy Sand	Gray Sandstone
90 - 100 I.B.	53930	7.3	1.72	27.7	6.48	0.18	8.09	0.22	4.30	0.12	1.59	Sand	Gray Sandstone
100 - 110 I.B.	53931	7.8	1.30	28.2	7.35	0.21	6.23	0.18	2.85	0.08	1.09	Loamy Sand	Gray Sandstone
110 - 113 I.B.	53932	8.3	1.30	29.0	7.69	0.22	5.99	0.17	3.17	0.09	1.21	Sand	Gray Sandstone

*Oven Dry Soil
**U. S. Department of Agriculture Soil Textural Triangle

NORTHERN TESTING LABORATORIES, INC.
CONSULTING GEOTECHNICAL ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

ANALYSIS OF TRACE ELEMENTS IN OVERBURDEN
AREA A, SECTION 5
WESTERN ENERGY COMPANY - COLSTRIP, MONTANA

February 17, 1976
Job No. 69-147

All In Parts Per Million .(-) Indicates Less Than Given Value

Sample Location	Depth, Ft.	Lab No.	Nitrate Nitrogen	Ammonia Nitrogen	Boron	Selenium	Molybdenum	Mercury	Zinc	Iron	Manganese	Copper	Cadmium	Lead	Nickel
N47000- E-6000	0 - 2	53921	2.94	5.9	1.12	0.02	0.35	0.040	9.85	7.6	6.59	1.55	0.02	0.9	0.06
	2 - 5	53922	-0.01	7.0	0.37	-0.02	0.31	0.034	0.49	3.8	2.44	0.66	-0.01	0.7	0.09
	5 - 15	53923	-0.01	5.0	0.37	-0.02	0.27	0.040	0.63	13.8	4.03	0.46	-0.01	0.6	0.08
	15 - 23	53924	-0.01	6.2	0.71	-0.02	0.20	0.095	111.0	26.1	13.7	1.68	0.07	1.1	0.37
	23 - 32	53925	-0.01	12.9	2.16	-0.02	2.55	0.370	5.63	174.0	0.99	0.99	0.02	0.1	2.30
I.B.	53 - 60	53926	-0.01	5.3	1.38	-0.02	0.24	0.155	16.7	25.8	5.02	2.55	0.01	3.8	1.42
I.B.	60 - 70	53927	-0.01	5.6	4.24	-0.02	0.22	0.034	459.0	1.6	1.95	0.12	0.19	0.3	0.85
I.B.	70 - 80	53928	-0.01	5.0	2.42	-0.02	0.21	0.039	25.1	15.3	4.65	0.73	0.03	1.2	0.73
I.B.	80 - 90	53929	-0.01	3.9	1.97	-0.02	-0.20	0.036	300.0	14.4	5.74	0.49	0.14	1.1	0.49
I.B.	90 - 100	53930	-0.01	4.2	1.38	-0.02	-0.20	0.049	153.0	17.9	4.48	0.50	0.03	1.2	0.68
I.B.	100 - 110	53931	-0.01	14.0	0.97	-0.02	0.20	0.045	102.0	19.8	3.75	0.39	0.03	1.3	0.65
I.B.	110 - 113	53932	-0.01	5.0	1.38	-0.02	0.21	0.049	75.8	14.9	4.90	0.35	0.01	1.0	0.63

NORTHERN TESTING LABORATORIES, INC.
CONSULTING GEOTECHNICAL ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

CHEMICAL ANALYSIS OF TOPSOIL AND OVERBURDEN
AREA A, SECTION 5
WESTERN ENERGY COMPANY - COLSTRIP, MONTANA
N49000 - E44000

February 24, 1976
Job No. 69-147

Depth, Feet	Lab No.	pH	Conductivity mmhos/cm	Saturation %	Calcium meq/Liter	Calcium meq/100 grams*	Magnesium meq/Liter	Magnesium meq/100 grams*	Sodium meq/Liter	Sodium meq/100 grams*	SAR	Texture**	Probable Subsurface Formation
0 - 3	54064	8.0	0.38	28.2	1.85	0.05	2.99	0.08	0.37	0.01	0.24	Sandy Loam	Brown Topsoil
3 - 7	54065	8.2	3.71	31.6	4.20	0.13	23.9	0.76	22.4	0.71	5.98	Sandy Clay Loam	Brown Topsoil
7 - 17	54066	8.1	7.36	38.0	22.4	0.85	62.0	2.36	38.4	1.40	5.91	Loam	Brown Sandy Topsoil
17 - 20	54067	7.9	5.42	66.2	19.1	1.26	41.5	2.75	25.1	1.66	4.56	Clay	Brown Clay
20 - 30	54068	7.4	1.17	68.7	4.17	0.29	5.85	0.40	4.65	0.32	2.08	Clay	Gray Shale
30 - 34	54069	7.4	2.31	46.5	10.3	0.48	13.1	0.61	7.55	0.35	2.21	Silt Loam	Gray Shale
34 - 44	54070	7.7	1.71	52.4	5.44	0.29	8.10	0.42	7.45	0.39	2.86	Silty Clay Loam	Gray Shale
44 - 54	54071	7.7	1.56	59.0	4.31	0.25	5.62	0.33	8.15	0.48	3.66	Clay	Gray Shale
54 - 64	54072	7.8	2.05	41.6	5.21	0.22	7.48	0.31	12.1	0.50	4.80	Silty Clay Loam	Gray Shale
64 - 74	54073	8.0	1.38	29.4	3.61	0.11	4.95	0.15	8.40	0.25	4.06	Sandy Loam	Brown Sandstone
74 - 84	54074	8.0	1.99	28.3	5.36	0.15	8.80	0.25	10.7	0.30	4.02	Sandy Loam	Brown Sandstone
84 - 95	54075	8.0	1.63	29.0	4.28	0.12	7.22	0.21	8.42	0.24	3.51	Sandy Loam	Gray Sandstone
95 - 100	54076	7.8	1.58	38.4	4.20	0.16	6.95	0.27	7.85	0.30	3.32	Clay Loam	Gray Sandy Shale
100 - 109	54077	7.7	2.07	36.7	7.45	0.27	9.56	0.35	8.88	0.33	3.05	Clay Loam	Gray Shale
109 - 118	54078	7.9	0.99	61.1	2.78	0.17	3.25	0.20	5.80	0.35	3.34	Silty Clay	Gray Shale
118 - 128	54079	8.0	1.01	55.7	2.66	0.15	2.86	0.16	6.05	0.34	3.64	Clay Loam	Gray Shale
128 - 138	54080	7.3	1.25	41.8	3.89	0.16	4.67	0.20	6.65	0.28	3.21	Clay Loam	Gray Sandy Shale
138 - 160 I.B.	54081	7.1	1.52	49.2	6.58	0.32	6.81	0.34	5.50	0.27	2.13	Silty Clay	Gray Shale
160 - 170 I.B.	54082	7.6	1.55	44.7	6.32	0.28	7.08	0.32	5.20	0.23	2.01	Silty Clay Loam	Gray Shale
170 - 180 I.B.	54083	7.7	1.90	49.5	7.36	0.36	8.84	0.44	6.35	0.31	2.23	Silty Clay Loam	Gray Shale
180 - 190 I.B.	54084	7.9	1.98	27.2	9.31	0.25	7.98	0.22	7.25	0.20	2.47	Loamy Sand	Gray Sandstone
190 - 200 I.B.	54085	7.7	1.95	28.7	8.46	0.24	8.49	0.24	7.55	0.22	2.59	Sandy Loam	Gray Sandstone
200 - 210 I.B.	54086	7.7	2.24	25.0	10.1	0.25	9.11	0.23	9.40	0.24	3.03	Sandy Loam	Gray Sandstone
210 - 220 I.B.	54087	7.7	1.97	23.4	9.78	0.29	9.78	0.29	4.90	0.14	1.57	Loamy Sand	Gray Sandstone

*Oven Dry Soil
**U. S. Department of Agriculture Soil Textural Triangle

NORTHERN TESTING LABORATORIES, INC.
CONSULTING GEOTECHNICAL ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

ANALYSIS OF TRACE ELEMENTS IN OVERBURDEN
AREA A, SECTION 5
WESTERN ENERGY COMPANY - COLSTRIP, MONTANA

February 24, 1976
Job No. 69-147

All in Parts Per Million (-) Indicates Less Than Given Value

ple cation	Depth, Ft.	Lab No.	Nitrate Nitrogen	Ammonia Nitrogen	Boron	Selenium	Molybdenum	Mercury	Zinc	Iron	Manganese	Copper	Cadmium	Lead	Nickel
3000 - 4000	0 - 3	54064	0.19	3.6	0.78	-0.02	-0.20	0.014	5.85	5.5	2.97	0.52	0.03	0.7	0.18
	3 - 7	54065	-0.01	3.4	0.82	-0.02	-0.20	0.017	1.43	7.9	1.99	0.73	0.03	0.6	0.17
	7 - 17	54066	-0.01	4.2	0.62	-0.02	-0.20	0.019	2.12	7.9	1.87	0.70	0.04	0.9	0.21
	17 - 20	54067	0.08	6.2	1.01	-0.02	-0.20	0.068	10.4	16.5	3.74	1.01	0.06	1.3	0.25
	20 - 30	54068	0.12	9.8	1.11	-0.02	0.24	0.059	7.65	20.4	4.55	5.98	0.07	6.5	0.84
	30 - 34	54069	0.12	9.2	0.88	-0.02	0.36	0.082	17.7	120.0	5.41	1.82	0.05	3.0	1.26
	34 - 44	54070	0.16	7.8	0.65	-0.02	0.32	0.040	29.9	77.9	10.4	3.03	0.07	4.4	1.55
	44 - 54	54071	0.12	8.1	0.43	-0.02	1.23	0.063	10.2	85.2	10.9	3.35	0.04	3.7	1.39
	54 - 64	54072	0.08	5.3	0.46	-0.02	0.58	0.051	11.0	62.8	5.62	1.89	0.05	3.5	1.36
	64 - 74	54073	0.16	4.5	0.72	-0.02	0.32	0.017	1.79	18.2	1.97	0.53	0.04	1.1	0.35
	74 - 84	54074	0.04	5.6	0.33	-0.02	0.27	0.034	49.7	18.3	2.49	0.78	0.05	1.2	0.23
	84 - 95	54075	0.04	2.5	0.10	-0.02	0.21	0.019	26.3	21.3	1.38	0.32	0.05	1.5	0.49
	95 - 100	54076	0.19	5.6	0.59	-0.02	0.43	0.047	5.49	60.4	5.69	2.29	0.05	4.6	1.75
	100 - 109	54077	0.04	7.3	0.56	-0.02	0.45	0.046	5.05	51.3	6.39	1.96	0.05	3.4	1.29
	109 - 118	54078	0.12	11.8	0.69	-0.02	-0.20	0.120	5.65	33.8	2.02	4.43	0.07	5.6	1.03
	118 - 128	54079	0.04	10.5	0.69	-0.02	-0.20	0.136	11.2	25.5	1.15	4.39	0.07	4.7	0.55
[illegible] coal →	128 - 138	54080	0.12	7.3	1.21	-0.02	-0.20	0.045	6.83	17.3	1.20	1.21	0.11	5.2	1.35
I.B.	138 - 160	54081	0.23	8.1	2.94	-0.02	0.32	0.080	8.42	31.3	5.27	2.39	0.09	7.2	1.36
I.B.	160 - 170	54082	0.12	5.3	0.78	-0.02	0.61	0.061	17.3	62.0	8.67	2.48	0.08	4.3	0.56
I.B.	170 - 180	54083	0.12	5.9	0.92	-0.02	0.42	0.057	240.0	51.2	7.41	2.37	0.20	5.6	0.55
I.B.	180 - 190	54084	0.04	2.2	0.65	-0.02	0.31	0.032	678.0	8.4	4.02	0.22	0.35	0.3	0.63
I.B.	190 - 200	54085	0.23	3.6	0.92	-0.02	0.24	0.030	576.0	16.2	6.90	0.58	0.36	2.1	0.70
I.B.	200 - 210	54086	0.04	3.1	0.52	-0.02	0.20	0.019	642.0	10.8	5.25	0.28	0.35	0.5	0.69
I.B.	210 - 220	54087	-0.01	2.5	0.52	-0.02	-0.20	0.017	492.0	22.2	3.85	0.41	0.28	1.8	0.53

NORTHERN TESTING LABORATORIES, INC.
CONSULTING GEOTECHNICAL ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

CHEMICAL ANALYSIS OF TOPSOIL AND OVERBURDEN
AREA A, SECTION 5
N49000-E46000

February 17, 1976
Job No. 69-147

Depth, Feet	Lab No.	pH	Conductivity mmhos/cm	Saturation %	Calcium meq/Liter	Calcium meq/100 grams*	Magnesium meq/Liter	Magnesium meq/100 grams*	Sodium meq/Liter	Sodium meq/100 grams*	SAR	Texture**	Probable Subsurface Formation
0 - 3	53933	8.1	9.19	29.1	21.8	0.63	47.2	1.37	69.0	2.01	11.75	Loam	Brown Topsoil
3 - 14	53934	8.0	2.99	31.4	5.74	0.18	11.9	0.37	19.6	0.62	6.60	Sandy Loam	Brown Topsoil
14 - 17	53935	8.1	1.84	32.6	2.09	0.07	6.10	0.20	12.0	0.39	5.93	Loamy Sand	Brown Sandstone
17 - 21	53936	8.0	2.29	35.0	3.20	0.11	8.87	0.31	14.3	0.50	5.82	Sandy Loam	Brown Sandstone
21 - 31	53937	8.1	2.28	33.3	3.04	0.10	10.7	0.36	13.2	0.44	5.04	Sandy Loam	Brown Sandstone
31 - 47	53938	8.0	2.67	29.9	4.46	0.13	13.9	0.42	13.4	0.40	4.42	Sandy Loam	Brown Sandstone
47 - 57	53939	8.1	2.16	30.1	4.15	0.12	11.1	0.33	10.8	0.33	3.91	Loamy Sand	Brown Sandstone
57 - 64	53940	8.2	0.99	25.8	2.55	0.07	4.27	0.11	4.04	0.10	2.19	Loamy Sand	Brown Sandstone
64 - 67	53941	7.8	1.08	48.9	2.59	0.13	4.92	0.24	3.82	0.19	1.97	Clay	Gray Shale
67 - 77	53942	7.8	1.33	46.0	4.32	0.20	5.99	0.28	4.48	0.21	1.97	Silty Clay Loam	Gray Shale
77 - 87	53943	7.7	1.98	49.9	6.70	0.34	9.82	0.49	5.90	0.30	2.05	Clay Loam	Gray Shale
87 - 97	53944	8.0	0.85	71.3	2.12	0.15	2.51	0.18	4.30	0.31	2.83	Clay	Gray Shale
106 - 116 I.B.	53945	7.2	1.79	32.6	7.59	0.25	7.71	0.25	4.55	0.15	1.65	Sandy Loam	Gray Sandstone
120 - 130 I.B.	53946	7.7	2.05	31.7	8.78	0.28	8.13	0.26	6.82	0.22	2.35	Sandy Loam	Gray Sandstone
130 - 140 I.B.	53947	7.6	2.35	32.3	13.7	0.44	10.1	0.32	6.20	0.20	1.80	Sandy Loam	Gray Sandstone
140 - 150 I.B.	53948	7.8	2.47	28.3	12.6	0.35	11.1	0.31	7.26	0.20	2.11	Sandy Loam	Gray Sandstone
150 - 160 I.B.	53949	7.8	2.91	22.9	22.0	0.51	10.8	0.25	6.30	0.15	1.56	Loamy Sand	Gray Sandstone
160 - 170 I.B.	53950	8.0	3.14	23.5	23.2	0.56	13.2	0.32	6.60	0.16	1.55	Sandy Loam	Gray Sandstone
170 - 176 I.B.	53951	7.9	2.20	26.5	16.4	0.44	6.98	0.19	4.70	0.13	1.38	Loamy Sand	Gray Sandstone

*Oven Dry Soil
**U. S. Department of Agriculture Soil Textural Triangle

NORTHERN TESTING LABORATORIES, INC.
CONSULTING GEOTECHNICAL ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

REVISED: March 23, 1976
February 17, 1976
Job No. 69-147

ANALYSIS OF TRACE ELEMENTS IN OVERBURDEN
AREA A, SECTION 5
WESTERN ENERGY COMPANY - COLSTRIP, MONTANA

All In Parts Per Million (-) Indicates Less Than Given Value

Sample Location	Depth, Ft.	Lab No.	Nitrate Nitrogen	Ammonia Nitrogen	Boron	Selenium	Molybdenum	Mercury	Zinc	Iron	Manganese	Copper	Cadmium	Lead	Nickel
45000-	0 - 3	53933	-0.01	5.9	0.25	-0.02	0.70	0.024	6.83	7.9	4.67	0.74	0.01	0.6	0.29
46000	3 - 14	53934	-0.01	7.0	0.71	-0.02	0.34	0.013	1.53	10.2	8.08	0.36	0.01	0.3	0.18
	14 - 17	53935	-0.01	5.3	0.41	-0.02	0.23	0.011	0.35	6.2	2.59	0.36	0.35	0.7	0.21
	17 - 21	53936	-0.01	4.5	0.52	-0.02	0.20	0.020	15.9	6.6	4.85	0.30	0.01	0.3	0.24
	21 - 31	53937	-0.01	6.7	0.33	-0.02	-0.20	0.024	2.56	5.5	1.74	0.25	0.01	0.5	0.26
	31 - 47	53938	-0.01	5.0	0.37	0.02	0.20	0.019	6.82	12.2	4.08	0.37	-0.01	0.6	0.29
	47 - 57	53939	-0.01	14.8	0.22	-0.02	0.20	0.015	3.89	8.1	3.45	0.49	0.01	0.6	0.31
	57 - 64	53940	1.17	5.6	0.45	-0.02	-0.20	0.019	6.80	16.2	3.57	0.77	0.03	0.7	0.45
	64 - 67	53941	-0.01	12.0	0.22	0.02	0.57	0.082	11.8	110.0	12.2	2.58	0.03	4.6	1.92
	67 - 77	53942	-0.01	8.1	0.60	-0.02	0.72	0.070	14.4	93.5	10.9	3.68	0.04	5.6	2.51
	77 - 87	53943	-0.01	6.2	0.82	0.02	0.69	0.107	22.5	70.5	9.39	6.82	0.05	3.9	2.47
	87 - 97	53944	-0.01	11.2	1.19	0.02	0.42	0.146	7.30	39.9	2.64	5.89	0.02	7.4	1.51
I.B.	106 - 116	53945	-0.01	4.5	1.53	0.03	0.32	0.091	93.0	17.6	4.32	0.81	0.06	1.7	1.00
I.B.	120 - 130	53946	-0.01	-0.01	1.26	-0.02	0.28	0.059	522.0	3.7	3.30	0.16	0.20	-0.1	0.95
I.B.	130 - 140	53947	-0.01	5.6	0.67	-0.02	0.36	0.038	612.0	2.0	2.29	0.16	0.20	-0.1	0.96
I.B.	140 - 150	53948	-0.01	5.4	0.45	-0.02	0.42	0.049	585.0	1.9	2.80	0.18	0.19	-0.1	0.86
I.B.	150 - 160	53949	-0.01	5.0	0.37	-0.02	0.25	0.036	83.0	17.9	5.08	0.43	0.06	1.3	0.88
I.B.	160 - 170	53950	-0.01	3.6	0.71	-0.02	0.29	0.038	342.0	8.1	3.74	0.25	0.22	0.1	0.94
I.B.	170 - 176	53951	-0.01	2.5	0.74	-0.02	0.22	0.003	185.0	18.1	5.48	0.32	0.11	1.2	0.79

NORTHERN TESTING LABORATORIES, INC.
CONSULTING GEOTECHNICAL ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

CHEMICAL ANALYSIS OF TOPSOIL AND OVERBURDEN
AREA A, SECTION 5
WESTERN ENERGY COMPANY - COLSTRIP, MONTANA
N49000 - E48000

Job No. 69-147
February 24, 1976

Depth, Feet	Lab No.	pH	Conductivity mmhos/cm	Saturation %	Calcium meq/Liter	Calcium meq/100 grams*	Magnesium meq/Liter	Magnesium meq/100 grams*	Sodium meq/Liter	Sodium meq/100 grams*	SAR	Texture**	Probable Subsurface Formation
0 - 1	54043	7.7	0.59	29.8	4.19	0.12	2.82	0.08	0.45	0.01	0.24	Sandy Loam	Brown Topsoil
1 - 4	54044	8.2	0.51	32.4	1.00	0.03	3.95	0.13	1.33	0.04	0.85	Clay Loam	Brown Topsoil
4 - 8	54045	8.1	1.01	39.4	1.79	0.07	7.15	0.28	3.38	0.13	1.60	Silty Clay Loam	Brown Topsoil
8 - 11	54046	7.9	0.90	44.7	2.30	0.10	6.30	0.28	2.40	0.11	1.16	Silty Clay	Brown Clay
11 - 16	54047	8.0	0.74	38.7	2.11	0.08	5.95	0.23	1.55	0.06	0.77	Silty Clay Loam	Brown Clay
16 - 18	54048	8.0	0.73	37.1	1.80	0.07	5.41	0.20	1.20	0.04	0.63	Silty Clay Loam	Gray Shale
18 - 20	54049	8.2	0.77	34.1	2.49	0.08	5.51	0.19	1.15	0.04	0.58	Silt Loam	Brown Sandy Shale
20 - 27	54050	7.7	1.01	51.8	4.07	0.21	7.00	0.36	1.10	0.06	0.47	Silty Clay	Brown Shale
27 - 38	54051	7.8	1.21	35.2	5.58	0.20	8.04	0.28	1.37	0.05	0.53	Silt Loam	Brown Shale
38 - 40	54052	7.8	1.01	48.3	4.22	0.20	6.50	0.31	1.04	0.05	0.45	Silty Clay	Gray Shale
40 - 46	54053	8.1	1.08	30.9	3.37	0.10	7.99	0.25	1.20	0.04	0.50	Silt Loam	Gray Sandy Shale
46 - 53	54054	8.0	0.69	38.7	2.82	0.11	4.27	0.17	1.30	0.05	0.69	Silt Loam	Brown Shale
53 - 56	54055	7.9	1.06	32.9	4.17	0.14	7.00	0.23	1.93	0.06	0.82	Loam	Gray Sandy Shale
56 - 66	54056	7.8	1.72	30.9	6.19	0.19	8.10	0.25	5.20	0.16	1.95	Sandy Clay Loam	Gray Sandstone
66 - 71	54057	7.5	1.70	47.7	7.03	0.34	9.05	0.43	4.90	0.23	1.73	Clay Loam	Gray Shale
104 - 108 I.B.	54058	7.1	1.75	43.1	6.41	0.28	8.34	0.36	7.85	0.34	2.89	Clay Loam	Gray Shale
116 - 126 I.B.	54059	7.2	1.52	26.8	7.29	0.20	7.10	0.19	4.30	0.12	1.60	Loamy Sand	Gray Sandstone
126 - 136 I.B.	54060	7.4	1.58	30.6	8.02	0.25	6.32	0.19	4.65	0.14	1.74	Sand	Gray Sandstone
136 - 146 I.B.	54061	7.4	1.38	27.0	7.19	0.19	5.29	0.14	3.80	0.10	1.52	Loamy Sand	Gray Sandstone
146 - 156 I.B.	54062	7.7	1.30	28.5	6.54	0.19	4.36	0.12	3.55	0.10	1.52	Sand	Gray Sandstone
156 - 165 I.B.	54063	7.6	1.54	28.6	7.48	0.21	4.51	0.13	4.75	0.14	1.94	Sand	Gray Sandstone

*Oven Dry Soil **U. S. Department of Agriculture Soil Textural Triangle

NORTHERN TESTING LABORATORIES, INC
CONSULTING GEOTECHNICAL ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

ANALYSIS OF TRACE ELEMENTS IN OVERBURDEN
AREA A, SECTION 5
WESTERN ENERGY COMPANY - COLSTRIP, MONTANA

February 24, 1976
Job No. 69-147

All in Parts Per Million (-) Indicates Less Than Given Value

Sample Location	Depth, Ft.	Lab No.	Nitrate Nitrogen	Ammonia Nitrogen	Boron	Selenium	Molydbenum	Mercury	Zinc	Iron	Manganese	Copper	Cadmium	Lead	Nickel
N-3000 -	0 - 1	54043	1.98	10.1	0.56	-0.02	-0.20	0.011	22.4	13.4	7.65	0.66	0.05	0.8	0.37
E -8000	1 - 4	54044	0.08	4.2	1.08	-0.02	-0.20	0.021	9.37	10.2	4.49	0.57	0.02	0.6	0.15
	4 - 8	54045	-0.01	5.6	0.78	-0.02	-0.20	0.028	14.3	12.8	5.15	0.41	0.02	1.4	0.12
	8 - 11	54046	0.62	5.0	0.52	-0.02	-0.20	0.045	14.7	21.8	5.39	1.85	0.04	1.2	0.35
	11 - 16	54047	0.39	6.2	0.56	-0.02	-0.20	0.024	2.94	10.5	1.90	0.94	0.04	1.2	0.12
	16 - 18	54048	0.04	10.9	0.26	-0.02	-0.20	0.055	1.70	28.1	1.85	3.37	0.01	3.4	0.47
	18 - 20	54049	-0.01	16.0	0.56	-0.02	-0.20	0.032	0.79	6.2	1.37	1.20	0.04	0.8	0.12
	20 - 27	54050	0.08	9.0	0.39	-0.02	0.27	0.063	23.2	46.9	7.83	2.79	0.04	4.3	1.43
	27 - 38	54051	0.04	8.7	0.20	-0.02	-0.20	0.047	4.56	18.6	2.95	1.65	0.04	1.7	0.76
	38 - 40	54052	0.23	8.4	0.56	-0.02	0.32	0.036	7.16	36.3	2.93	3.82	0.06	5.3	1.62
	40 - 46	54053	-0.01	5.3	0.36	-0.02	0.26	0.026	28.9	23.3	3.18	1.97	0.05	2.1	0.67
	46 - 53	54054	-0.01	4.5	0.16	-0.02	-0.20	0.032	34.2	16.6	8.23	1.07	0.06	1.7	0.60
	53 - 56	54055	0.04	3.4	0.10	-0.02	-0.20	0.032	4.75	37.5	4.84	1.04	0.04	2.1	0.79
	56 - 66	54056	-0.01	6.4	0.29	-0.02	0.51	0.052	77.2	39.5	4.65	2.36	0.08	3.7	1.75
	66 - 71	54057	-0.01	7.8	0.98	-0.02	0.80	0.063	12.2	73.5	10.5	3.25	0.06	3.8	0.83
I.B.	104 - 108	54058	0.43	4.8	2.29	-0.02	1.04	0.151	129.0	24.9	4.10	2.12	0.12	4.7	0.69
I.B.	116 - 126	54059	-0.01	3.6	1.70	-0.02	-0.20	0.036	216.0	12.4	5.06	0.67	0.13	2.0	0.69
I.B.	126 - 136	54060	0.17	2.9	1.11	-0.02	0.20	0.019	53.9	13.9	2.73	0.42	0.06	1.4	0.67
I.B.	136 - 146	54061	0.19	3.1	1.18	-0.02	-0.20	0.026	135.0	17.2	3.61	0.47	0.09	1.8	0.72
I.B.	146 - 156	54062	-0.01	2.8	0.43	-0.02	-0.20	0.019	42.3	14.3	1.79	0.58	0.05	1.3	0.67
I.B.	156 - 165	54063	-0.01	2.8	0.59	-0.02	-0.20	0.019	38.4	13.5	2.09	0.60	0.04	1.4	0.51

NORTHERN TESTING LABORATORIES, INC.
CONSULTING GEOTECHNICAL ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

CHEMICAL ANALYSIS OF TOPSOIL AND OVERBURDEN
AREA A, SECTION 4
N49000-E50000
WESTERN ENERGY COMPANY - COLSTRIP, MONTANA

February 17, 1976
Job No. 69-147

epth. Feet	Lab No.	pH	Conductivity mmhos/cm	Saturation %	Calcium meq/Liter	Calcium meq/100 grams*	Magnesium meq/Liter	Magnesium meq/100 grams*	Sodium meq/Liter	Sodium meq/100 grams*	SAR	Texture**	Probable Subsurface Formation
0 - 3	53885	8.1	0.35	30.6	2.12	0.07	2.20	0.07	0.37	0.01	0.25	Loam	Brown Topsoil
3 - 8	53826	8.1	9.95	39.7	23.1	0.92	61.5	2.44	38.2	1.52	5.87	Silt Loam	Brown Sandy Clay
8 - 12	53887	7.8	3.79	50.4	28.1	1.42	24.6	1.24	5.96	0.30	1.16	Silty Clay	Brown Clay
12 - 15	53888	7.7	2.06	42.8	16.7	0.71	12.0	0.51	1.72	0.07	0.45	Silty Clay Loam	Brown Clay
15 - 20	53889	7.7	0.89	57.0	4.09	0.23	5.35	0.31	1.43	0.08	0.66	Clay	Brown Shale
20 - 25	53890	7.4	3.04	65.3	16.7	1.09	23.0	1.50	2.45	0.16	0.55	Clay	Gray Brown Shale
51 - 55 I.B.	53891	7.1	2.12	37.6	8.23	0.31	11.1	0.42	6.18	0.23	1.99	Loam	Gray Shale
55 - 60 I.B.	53892	7.7	2.10	25.1	12.1	0.30	9.01	0.23	4.62	0.12	1.42	Sandy Loam	Gray Sandstone
60 - 70 I.B.	53893	7.8	1.40	27.7	7.82	0.22	4.61	0.13	3.12	0.09	1.25	Sand	Gray Sandstone
70 - 80 I.B.	53894	7.4	1.50	32.7	8.17	0.27	4.08	0.13	3.71	0.12	1.50	Sand	Gray Sandstone
80 - 90 I.B.	53895	7.8	1.40	30.6	7.44	0.23	4.27	0.13	3.26	0.10	1.35	Sand	Gray Sandstone
90 - 97 I.B.	53896	7.2	2.45	28.0	13.6	0.38	9.73	0.27	5.99	0.17	1.75	Sand	Gray Sandstone
97 - 100 I.B.	53897	7.8	2.19	29.1	11.2	0.33	10.0	0.29	5.34	0.16	1.64	Sandy Clay Loam	Gray Sandstone

*Oven Dry Soil
**U. S. Department of Agriculture Soil Textural Triangle

NORTHERN TESTING LABORATORIES, INC.
CONSULTING GEOTECHNICAL ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

ANALYSIS OF TRACE ELEMENTS IN OVERBURDEN
AREA A, SECTION 4
WESTERN ENERGY COMPANY - COLSTRIP, MONTANA

February 17, 1976
Job No. 69-147

All In Parts Per Million (-) Indicates Less Than Given Value

Sample Location	Depth, Ft.	Lab No.	Nitrate Nitrogen	Ammonia Nitrogen	Boron	Selenium	Molybdenum	Mercury	Zinc	Iron	Manganese	Copper	Cadmium	Lead	Nickel
[illegible]	0 - 3	53885	1.00	10.9	0.16	-0.02	0.48	0.082	85.0	5.5	14.1	0.56	0.07	0.7	0.30
[illegible]	3 - 8	53886	-0.01	14.0	1.60	-0.02	0.42	0.053	154.0	9.7	33.4	0.81	0.11	0.9	0.46
	8 - 12	53887	-0.01	14.6	0.49	-0.02	0.36	0.042	3.98	28.9	8.83	1.20	0.02	1.1	0.21
	12 - 15	53888	0.72	7.3	0.29	-0.02	0.26	0.074	1.64	29.9	16.1	0.88	0.02	1.1	0.25
	15 - 20	53889	-0.01	9.0	0.32	-0.02	0.39	0.125	1.41	19.3	3.90	1.79	0.02	1.6	0.30
	20 - 25	53890	0.39	18.6	0.43	-0.02	-0.20	0.138	12.1	17.8	13.1	1.83	0.04	2.3	0.77
I.B.	51 - 55	53891	-0.01	10.9	1.67	-0.02	1.58	0.140	17.5	84.8	5.64	1.24	0.03	3.9	0.48
I.B.	55 - 60	53892	0.22	9.0	1.47	-0.02	0.67	0.066	387.0	2.8	2.48	0.18	0.24	-0.1	0.37
I.B.	60 - 70	53893	-0.01	7.3	0.72	-0.02	0.46	0.049	241.0	10.6	3.29	0.33	0.14	1.5	0.72
I.B.	70 - 80	53894	-0.01	5.3	0.36	-0.02	0.36	0.042	34.9	11.2	1.24	0.28	0.02	1.5	0.42
I.B.	80 - 90	53895	-0.01	9.2	0.43	-0.02	0.34	0.051	156.0	19.8	2.43	0.51	0.09	1.3	0.65
I.B.	90 - 97	53896	-0.01	8.4	0.95	-0.02	0.40	0.082	152.0	26.5	3.29	0.52	0.08	1.8	1.00
I.B.	97 - 100	53897	-0.01	6.2	0.85	-0.02	0.46	0.104	199.0	39.3	6.34	1.73	0.11	3.8	1.25

NORTHERN TESTING LABORATORIES, INC.
CONSULTING GEOTECHNICAL ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

CHEMICAL ANALYSIS OF TOPSOIL AND OVERBURDEN
AREA A, SECTION 4
N49000-E52000
WESTERN ENERGY COMPANY - COLSTRIP, MONTANA

February 17, 1976
Job No. 69-147

Depth, Feet	Lab No.	pH	Conductivity mmhos/cm	Saturation %	Calcium meq/Liter	Calcium meq/100 grams*	Magnesium meq/Liter	Magnesium meq/100 grams*	Sodium meq/Liter	Sodium meq/100 grams*	SAR	Texture**	Probable Subsurfac Formation
0 - 2	53898	7.9	0.38	30.2	1.67	0.05	2.34	0.07	0.48	0.01	0.34	Sandy Loam	Brown Topsoil
2 - 5	53899	8.4	0.91	27.7	0.69	0.01	3.78	0.10	5.24	0.15	3.51	Loam	Lt. Brown Sandy Clay
5 - 9	53900	8.1	3.10	29.8	3.77	0.11	21.6	0.64	11.1	0.33	3.12	Silt Loam	Brown Clay
9 - 12	53901	8.3	0.60	30.5	0.83	0.03	3.73	0.11	2.10	0.06	1.39	Sandy Loam	Brown Sandstone
12 - 16	53902	8.2	0.45	49.1	0.93	0.05	3.11	0.15	1.10	0.05	0.77	Silty Clay Loam	Brown Shale
16 - 19	53903	8.2	0.50	30.8	1.40	0.04	2.83	0.09	1.16	0.04	0.80	Sandy Loam	Brown Sandstone
19 - 22	53904	8.0	0.51	32.2	1.95	0.06	2.93	0.09	1.15	0.04	0.74	Loam	Brown Sandy Shale
22 - 24	53905	7.6	1.34	27.6	7.84	0.22	8.29	0.23	1.40	0.04	0.49	Sandy Loam	Brown Sandstone
24 - 26	53906	7.8	0.85	27.5	3.11	0.09	4.49	0.12	2.20	0.06	1.13	Sandy Loam	Brown Sandstone
26 - 36	53907	7.6	1.76	32.5	8.69	0.28	11.2	0.36	1.95	0.06	0.62	Loam	Lt. Brown Sandy Sh
58 - 68 I.B.	53908	7.5	2.20	51.1	10.2	0.52	11.3	0.58	5.12	0.26	1.56	Clay	Gray Shale
68 - 75 I.B.	53909	7.5	2.31	40.5	13.3	0.54	12.2	0.49	5.24	0.21	1.47	Clay Loam	Gray Shale
75 - 80 I.B.	53910	7.4	2.09	34.0	10.7	0.36	10.1	0.34	5.58	0.19	1.73	Loam	Gray Sandy Shale
80 - 85 I.B.	53911	7.3	3.02	38.9	19.0	0.74	16.7	0.65	5.99	0.23	1.42	Clay Loam	Gray Sandy Shale

*Oven Dry Soil
**U. S. Department of Agriculture Soil Textural Triangle

NORTHERN TESTING LABORATORIES, INC.
CONSULTING GEOTECHNICAL ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

ANALYSIS OF TRACE ELEMENTS IN OVERBURDEN
AREA A, SECTION 4
WESTERN ENERGY COMPANY - COLSTRIP, MONTANA

February 17, 1976
Job No. 69-147

All In Parts Per Million (-) Indicates Less Than Given Value

Sample Location	Depth, Ft.	Lab No.	Nitrate Nitrogen	Ammonia Nitrogen	Boron	Selenium	Molybdenum	Mercury	Zinc	Iron	Manganese	Copper	Cadmium	Lead	Nickel
-5000-	0 - 2	53898	-0.01	6.4	0.39	-0.02	0.44	0.045	2.31	5.6	5.15	0.50	-0.01	0.4	0.09
10000	2 - 5	53899	-0.01	7.6	0.16	-0.02	0.41	0.043	1.32	5.7	3.03	0.53	-0.01	0.4	0.07
	5 - 9	53900	-0.01	8.1	0.03	-0.02	0.36	0.032	4.14	8.8	6.27	0.60	-0.01	0.5	0.04
	9 - 12	53901	-0.01	7.0	0.16	-0.02	0.24	0.049	0.59	14.9	2.83	0.37	-0.01	0.7	0.05
	12 - 16	53902	-0.01	6.7	0.20	-0.02	0.27	0.057	1.48	10.7	4.70	0.48	-0.01	1.1	0.03
	16 - 19	53903	0.05	8.4	0.23	0.02	0.30	0.049	0.66	7.0	4.55	0.39	-0.01	0.8	0.03
	19 - 22	53904	-0.01	5.3	0.26	-0.02	0.24	0.055	0.36	8.3	8.08	0.46	-0.01	0.3	0.01
	22 - 24	53905	-0.01	6.7	0.20	-0.02	0.26	0.047	12.8	12.0	14.3	0.65	-0.01	0.4	0.15
	24 - 26	53906	-0.01	6.4	0.23	-0.02	-0.20	0.051	5.9	5.8	3.49	0.46	-0.01	0.6	-0.01
	26 - 36	53907	-0.01	8.1	0.16	-0.02	0.35	0.097	84.5	119.0	36.1	1.25	0.05	1.5	1.17
1.B.	58 - 68	53908	0.05	14.3	1.60	-0.02	0.42	0.095	139.0	32.0	7.86	2.34	0.10	6.6	1.43
1.B.	68 - 75	53909	-0.01	11.8	0.78	-0.02	0.45	0.118	138.0	40.5	14.2	2.01	0.08	3.9	1.11
1.B.	75 - 80	53910	-0.01	7.6	1.18	0.02	0.33	0.070	94.0	36.1	15.3	1.36	0.05	3.2	0.76
1.B.	80 - 85	53911	-0.01	8.4	1.70	-0.02	0.36	0.085	350.0	2.5	6.00	0.27	0.19	0.1	1.32

NORTHERN TESTING LABORATORIES, INC.
CONSULTING GEOTECHNICAL ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

CHEMICAL ANALYSIS OF TOPSOIL AND OVERBURDEN
AREA A, SECTION 4
N50000-E52000
WESTERN ENERGY COMPANY - COLSTRIP, MONTANA

February 17, 1976
Job No. 69-147

. Feet	Lab No.	pH	Conductivity mmhos/ cm	Saturation %	Calcium meq/ Liter	Calcium meq/ 100 grams*	Magnesium meq/Liter	Magnesium meq/ 100 grams*	Sodium meq/ Liter	Sodium meq/ 100 grams*	SAR	Texture**	Probable Subsurface Formation
- 10	53912	8.0	0.50	32.8	1.85	0.06	3.36	0.11	0.95	0.03	0.59	Clay Loam	Brown Topsoil
- 16	53913	8.0	8.40	26.1	23.7	0.62	50.4	1.32	56.9	1.49	9.35	Sandy Loam	Brown Topsoil
- 20	53914	8.2	10.2	32.2	25.7	0.83	37.5	1.21	64.0	2.06	11.39	Clay Loam	Brown Sandy Shale
- 22	53915	8.1	5.75	28.0	21.3	0.60	39.9	1.12	28.1	0.79	5.08	Sandy Loam	Brown Sandstone
- 26	53916	8.0	3.51	29.1	15.4	0.45	23.4	0.68	12.5	0.36	2.84	Sandy Loam	Brown Sandstone
- 29	53917	6.8	1.70	71.7	9.88	0.71	9.49	0.68	2.84	0.20	0.91	Clay	Brown Shale
- 61 I.B.	53913	6.5	2.31	51.7	10.5	0.54	14.9	0.77	3.62	0.19	1.02	Silty Clay Loam	Gray Shale
- 71 I.B.	53919	8.0	2.07	25.9	6.69	0.17	10.7	0.28	6.98	0.18	2.37	Sandy Loam	Gray Sandstone
- 75 I.B.	53920	7.1	3.15	44.9	19.5	0.88	19.5	0.88	6.40	0.29	1.45	Silty Clay	Gray Shale

*Oven Dry Soil
**U. S. Department of Agriculture Soil Textural Triangle

NORTHERN TESTING LABORATORIES, INC.
CONSULTING GEOTECHNICAL ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

February 17, 1976
Job No. 69-147

ANALYSIS OF TRACE ELEMENTS IN OVERBURDEN
AREA A, SECTION 4
WESTERN ENERGY COMPANY - COLSTRIP, MONTANA

All In Parts Per Million (-) Indicates Less Than Given Value

Sample Location	Depth, Ft.	Lab No.	Nitrate Nitrogen	Ammonia Nitrogen	Boron	Selenium	Molybdenum	Mercury	Zinc	Iron	Manganese	Copper	Cadmium	Lead	Nickel
[illegible]- [illegible]	0 - 10	53912	2.94	6.7	1.31	-0.02	0.54	0.047	173.0	21.6	37.9	1.23	0.11	0.9	0.39
	10 - 16	53913	-0.01	4.8	0.78	-0.02	0.62	0.040	4.68	9.5	3.43	0.79	-0.01	0.5	0.05
	16 - 20	53914	-0.01	5.0	0.72	-0.02	0.50	0.043	11.4	26.6	10.0	1.05	-0.01	1.0	0.09
	20 - 22	53915	0.28	6.2	0.29	-0.02	0.20	0.032	2.26	14.3	4.98	0.56	-0.01	0.5	0.05
	22 - 26	53916	-0.01	5.9	0.29	-0.02	0.40	0.078	378.0	2.3	11.0	0.45	0.22	0.2	0.43
	26 - 29	53917	-0.01	12.6	0.52	-0.02	0.21	0.130	53.2	56.4	4.52	6.54	0.04	2.0	-0.01
	1.B. 51 - 61	53918	-0.01	17.6	2.49	-0.02	0.20	0.243	48.0	61.7	3.48	3.79	0.05	3.2	1.15
	1.3. 61 - 71	53919	-0.01	9.0	0.56	-0.02	0.66	0.069	11.5	33.4	3.40	1.70	-0.01	1.6	1.01
	1.3. 71 - 76	53920	-0.01	11.2	2.19	0.02	0.92	0.080	47.6	65.2	6.66	2.98	0.06	5.5	1.89

NORTHERN TESTING LABORATORIES, INC.
CONSULTING GEOTECHNICAL ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

January 9, 1976

Job No. 69-147

CHEMICAL ANALYSIS OF TOPSOIL AND OVERBURDEN
AREA A, SECTION 32
51000N, 48000E
WESTERN ENERGY COMPANY
COLSTRIP, MONTANA

Depth, Feet	Lab No.	pH	Conductivity mmhos/cm	Saturation %	Calcium meq/Liter	Calcium meq/100 grams*	Magnesium meq/Liter	Magnesium meq/100 grams*	Sodium meq/Liter	Sodium meq/100 grams*	SAR	Texture**	Probable Subsurface Formation
0'- 10'	52529	8.0	5.45	38.2	22.8	0.87	32.1	1.23	27.1	1.04	5.17	Loam	Lt. brown silt
10'- 20'	52530	8.0	4.55	31.9	21.0	0.67	26.0	0.83	19.3	0.62	3.98	Loam	Lt. brown silt
20'- 30'	52531	8.0	3.15	42.1	16.4	0.69	17.2	0.72	8.61	0.36	2.10	Clay Loam	Lt. brown clay
30'- 35'	52532	7.8	2.05	53.2	8.10	0.43	9.99	0.53	5.05	0.27	1.68	Silty Clay	Lt. brown clay
35'- 40'	52533	7.7	2.80	43.5	14.3	0.62	16.1	0.70	5.26	0.23	1.35	Clay loam	Dk. gray sandy shale
40'- 45'	52534	7.8	3.10	53.4	15.1	0.81	21.6	1.15	5.59	0.30	1.30	Silty Clay loam	Dk. gray shale
45'- 50'	52535	8.2	1.30	28.3	3.76	0.11	6.83	0.19	3.35	0.09	1.46	Loam	Lt. brown sandy shale
50'- 60'	52536	8.2	1.15	28.6	3.28	0.09	6.15	0.18	2.65	0.08	1.23	Sandy loam	Brown sandstone
60'- 70'	52537	8.0	1.75	44.9	4.00	0.18	10.3	0.46	5.19	0.23	1.94	Loam	Gray-brown sandy shale
70'- 80'	52538	8.0	1.80	28.2	4.73	0.13	8.77	0.25	5.87	0.17	2.26	Sandy loam	Gray sandstone
80'- 90'	52539	7.9	2.20	38.5	7.41	0.29	8.14	0.31	9.11	0.35	3.27	Silt loam	Gray shale
90'-100'	52540	7.9	2.05	39.7	7.32	0.29	7.34	0.29	7.89	0.31	2.91	Sandy clay loam	Gray sandstone
I.S.140'-150'	52541	7.9	1.57	33.5	5.96	0.20	5.43	0.18	5.14	0.17	2.15	Loam	Gray sandy shale
I.S.150'-160'	52542	7.9	1.65	27.2	7.51	0.20	7.43	0.20	5.84	0.16	2.14	Sandy loam	Gray sandstone
I.S.160'-170'	52543	7.3	2.20	27.9	9.48	0.26	9.52	0.27	7.31	0.20	2.37	Sandy loam	Gray sandstone
I.S.170'-180'	52544	7.8	1.80	26.5	6.02	0.16	6.91	0.18	6.56	0.17	2.58	Sandy loam	Gray sandstone

*Oven-dry soil

**U.S. Department of Agriculture Soil Textural Triangle

NORTHERN TESTING LABORATORIES, INC.
CONSULTING GEOTECHNICAL ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

ANALYSIS OF TRACE ELEMENTS IN OVERBURDEN
AREA A, SECTION 32
WESTERN ENERGY COMPANY
COLSTRIP, MONTANA
All in Parts Per Million
(-) Indicates Less Than Given Value

January 9, 1976

Job No. 69-147

Sample Location	Depth	Lab No.	Nitrate Nitrogen	Ammonia Nitrogen	Boron	Selenium	Molybdenum	Mercury	Zinc	Iron	Manganese	Copper	Cadmium	Lead	Nickel
ALL.	0'- 10'	52529	0.33	16.8	0.33	-0.02	0.41	0.005	1.40	4.9	1.80	1.19	-0.01	0.56	0.18
	10'- 20'	52530	0.22	16.8	0.05	-0.02	0.30	0.008	7.43	6.9	4.27	1.21	-0.01	0.33	0.07
Area A	20'- 30'	52531	0.22	16.1	0.35	-0.02	0.32	0.014	14.4	22.2	9.11	4.43	-0.01	1.20	0.16
Sect. 32	30'- 35'	52532	0.22	18.3	0.00	-0.02	0.44	0.017	5.89	50.3	10.7	1.72	-0.01	3.56	0.58
51000N	35'- 40'	52533	0.33	19.7	0.05	-0.02	0.50	0.022	5.72	76.7	10.7	1.50	0.01	2.96	0.93
45000E	40'- 45'	52534	0.17	22.6	0.00	-0.02	0.78	0.029	6.05	38.4	6.38	2.63	0.03	3.82	1.66
	45'- 50'	52535	0.39	12.9	0.00	-0.02	0.25	0.014	2.95	8.0	5.00	0.73	-0.01	0.12	0.12
	50'- 60'	52536	0.17	15.4	0.00	-0.02	-0.20	0.012	1.90	5.8	1.75	0.56	-0.01	0.44	0.06
	60'- 70'	52537	0.17	16.5	0.00	-0.02	0.32	0.016	4.41	27.7	2.78	1.25	0.01	1.86	0.90
	70'- 80'	52538	1.39	14.3	0.00	-0.02	0.22	0.023	1.75	18.8	1.33	0.24	-0.01	0.97	0.46
	80'- 90'	52539	0.17	15.0	0.00	-0.02	0.42	0.029	3.68	34.0	3.01	1.37	0.01	2.86	1.32
	90'-100'	52540	1.33	16.1	0.10	-0.02	0.55	0.020	6.44	22.1	1.56	1.48	0.01	2.26	1.35
I.B.	140'-150'	52541	0.17	12.5	0.30	-0.02	0.33	0.019	6.24	21.7	1.66	3.62	0.02	1.85	0.82
I.B.	150'-160'	52542	0.17	15.8	0.00	-0.02	0.29	0.016	15.0	26.7	1.87	2.09	0.02	1.03	0.67
I.B.	160'-170'	52543	0.22	15.8	0.10	-0.02	0.41	0.015	2.53	25.6	2.04	1.52	0.01	1.63	1.33
I.B.	170'-180'	52544	0.17	20.0	0.05	-0.02	0.28	0.015	2.78	23.8	1.55	1.57	0.01	1.14	0.63

Certified ______________________

NORTHERN TESTING LABORATORIES, INC.
CONSULTING GEOTECHNICAL ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

January 9, 1976

Job No. 65-147

CHEMICAL ANALYSIS OF TOPSOIL AND OVERBURDEN
AREA A, SECTION 32
52000N, 47000E
WESTERN ENERGY COMPANY
COLSTRIP, MONTANA

Depth, Feet	Lab No.	pH	Conductivity mmhos/cm	Saturation %	Calcium meq/Liter	Calcium meq/100 grams*	Magnesium meq/Liter	Magnesium meq/100 grams*	Sodium meq/Liter	Sodium meq/100 grams*	SAR	Texture**	Probable Subsurface Formation
0'- 5'	52510	8.1	6.20	54.8	23.6	1.29	40.5	2.22	29.7	1.63	5.25	Silty clay loam	Lt. brown clay
5'- 10'	52511	8.2	8.50	52.9	23.2	1.23	58.9	3.12	52.6	2.78	8.21	Silty clay loam	Lt. brown clay
10'- 15'	52512	8.3	5.30	40.8	11.6	0.47	18.0	0.73	34.2	1.40	8.89	Silt loam	Lt. brown silt
15'- 20'	52513	7.2	6.50	85.8	20.3	1.74	26.4	2.27	42.9	3.68	8.88	Clay	Lt. brown clay
20'- 30'	52514	8.1	3.15	86.5	2.31	0.20	2.67	0.23	24.2	2.09	15.34	Silty clay	Gray shale
30'- 35'	52515	8.3	1.90	103.7	0.83	0.09	0.32	0.03	18.3	1.90	24.13	Silty clay	Gray-brown shale
35'- 40'	52516	8.2	2.90	88.3	1.15	0.10	0.68	0.06	27.6	2.44	28.85	Clay loam	Dk. brown shale
40'- 50'	52517	8.6	1.65	95.8	0.45	0.04	0.10	0.01	15.4	1.48	29.37	Clay loam	Gray-brown shale
50'- 60'	52518	8.6	1.30	103.6	0.41	0.04	0.03	-0.01	13.0	1.35	27.72	Silty clay loam	Brown shale
60'- 63'	52519	7.0	4.95	64.1	5.54	0.36	3.15	0.20	50.0	3.21	23.99	Clay	Dk. gray sandy shale
63'- 70'	52520	8.4	1.90	56.2	0.60	0.03	0.19	0.01	18.6	1.05	29.59	Silty Clay	Lt. gray shale
70'- 80'	52521	8.2	3.50	31.5	1.40	0.04	0.63	0.02	31.5	0.99	31.27	Silty clay loam	Lt. gray shale
80'- 90'	52522	8.4	5.10	35.9	1.12	0.04	0.94	0.03	50.6	1.82	49.86	Silty clay	Gray shale
90'-100'	52523	7.6	3.65	41.1	4.26	0.18	2.41	0.10	30.4	1.25	16.65	Silty clay loam	Gray shale
100'-110'	52524	8.3	1.50	40.2	1.30	0.05	1.00	0.04	16.9	0.68	15.76	Silty clay	Gray shale
110'-120'	52525	8.4	1.85	26.0	1.34	0.03	0.59	0.02	16.2	0.42	16.49	Loam	Gray sandy shale
120'-130'	52526	8.4	1.70	28.0	1.42	0.04	0.69	0.02	14.2	0.40	13.83	Sandy loam	Gray sandstone
130'-140'	52527	7.8	1.95	32.1	3.17	0.10	2.19	0.07	14.5	0.47	8.86	Sandy loam	Dk. gray sandstone
140'-150'	52528	8.0	1.55	29.4	2.47	0.07	2.07	0.06	10.3	0.30	6.84	Loamy sand	Gray sandstone

*Oven-dry soil

**U. S. Department of Agriculture Soil Textural Triangle

NORTHERN TESTING LABORATORIES, INC.
CONSULTING GEOTECHNICAL ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

January 9, 1976

Job No. 69-147

ANALYSIS OF TRACE ELEMENTS IN OVERBURDEN
AREA A, SECTION 32
52000N, 47000E
WESTERN ENERGY COMPANY
COLSTRIP, MONTANA
All In Parts Per Million
(-) Indicates Less Than Given Value

Sample Location	Depth	Lab No.	Nitrate Nitrogen	Ammonia Nitrogen	Boron	Selenium	Molybdenum	Mercury	Zinc	Iron	Manganese	Copper	Cadmium	Lead	Nickel
ALL	0'- 5'	52510	0.00	22.9	0.84	0.03	0.21	0.028	10.2	5.1	2.65	1.51	0.03	1.3	0.19
	5'- 10'	52511	0.22	18.3	0.00	-0.02	0.31	0.016	5.46	7.3	1.67	1.01	0.02	1.7	0.13
Area A	10'- 15'	52512	0.61	15.4	0.40	-0.02	0.20	0.016	2.92	7.0	2.78	1.48	-0.01	0.9	0.33
Sect. 32	15'- 20'	52513	0.89	19.3	0.69	-0.02	0.21	0.059	2.67	23.9	1.87	2.44	0.02	2.1	0.43
52000N	20'- 30'	52514	0.22	23.3	0.60	-0.03	-0.20	0.067	8.57	33.9	1.30	9.45	0.02	4.5	1.29
47000E	30'- 35'	52515	0.11	29.4	1.14	-0.02	0.65	0.032	4.40	48.0	8.56	2.88	0.01	4.6	1.55
	35'- 40'	52516	0.39	31.9	0.64	-0.02	0.70	0.043	5.03	47.8	13.9	2.53	0.01	1.8	2.04
	40'- 50'	52517	0.22	32.6	0.30	-0.02	0.52	0.024	4.79	36.4	4.13	1.91	0.01	3.6	1.87
	50'- 60'	52518	0.11	37.8	0.05	-0.02	0.59	0.017	2.53	37.4	6.20	1.57	0.01	3.2	1.63
	60'- 63'	52519	2.50	25.4	4.61	-0.02	0.39	0.008	6.23	67.9	3.95	3.08	0.01	3.8	2.62
	63'- 70'	52520	1.00	32.2	0.45	-0.02	1.20	0.017	2.76	48.4	6.72	3.28	0.01	4.7	0.70
	70'- 80'	52521	0.17	21.1	0.05	-0.02	1.10	0.014	2.27	46.5	5.77	2.58	-0.01	2.6	0.82
	80'- 90'	52522	0.28	20.4	0.05	-0.02	0.57	0.022	4.07	39.3	4.02	1.88	-0.01	9.2	1.93
	90'-100'	52523	0.28	19.3	0.69	-0.02	0.97	0.027	2.26	40.4	5.21	2.15	-0.01	3.6	1.34
	100'-110'	52524	0.06	26.9	0.20	-0.02	0.53	0.025	2.90	38.5	3.97	3.11	0.01	4.6	0.88
	110'-120'	52525	0.33	14.0	0.35	-0.02	0.43	0.003	1.88	27.7	2.00	0.66	-0.01	1.6	0.81
	120'-130'	52526	0.00	19.0	0.00	0.02	0.42	0.018	2.76	17.4	1.30	0.36	-0.01	1.3	0.69
	130'-140'	52527	0.11	15.0	0.00	-0.02	0.33	0.037	2.39	19.6	1.81	0.42	-0.01	0.7	0.55
	140'-150'	52528	0.06	16.5	0.00	-0.02	0.37	0.017	3.27	18.9	1.35	0.79	-0.01	1.1	0.84

B2-37

Certified____________________

NORTHERN TESTING LABORATORIES, INC.
CONSULTING GEOTECHNICAL ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

CHEMICAL ANALYSIS OF TOPSOIL AND OVERBURDEN
AREA A, SECTION 32
52000N-47000E
WESTERN ENERGY COMPANY - COLSTRIP, MONTANA

January 19, 1976
Job No. 69-147

epth, Feet	Lab No.	pH	Conductivity mmhos/ cm	Saturation %	Calcium meq/ Liter	Calcium meq/ 100 grams*	Magnesium meq/Liter	Magnesium meq/ 100 grams*	Sodium meq/ Liter	Sodium meq/ 100 grams*	SAR	Texture**	Probable Subsurface Formation
5 - 195 I.B.	52956	7.1	2.80	38.0	13.0	0.49	11.9	0.45	9.85	0.37	2.79	Silt Loam	Gray Sandy Shale
5 - 205 I.B.	52957	7.2	3.20	31.8	15.9	0.51	18.4	0.59	9.04	0.29	2.18	Sandy Loam	Gray Sandstone
5 - 215 I.B.	52958	7.4	2.25	51.3	6.40	0.33	7.94	0.41	11.3	0.58	4.22	Silt Loam	Gray Shale
5 - 225 I.B.	52959	7.8	2.05	30.3	6.96	0.21	8.74	0.26	8.23	0.25	2.94	Sandy Loam	Gray Sandstone
25 - 235 I.B.	52960	7.9	1.80	33.9	5.07	0.17	6.61	0.22	8.49	0.29	3.51	Loam	Gray Sandy Shale

*Oven Dry Soil
**U. S. Department of Agriculture Soil Textural Triangle

NORTHERN TESTING LABORATORIES, INC.
CONSULTING GEOTECHNICAL ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

ANALYSIS OF TRACE ELEMENTS IN OVERBURDEN
AREA A, SECTION 32
WESTERN ENERGY COMPANY - COLSTRIP, MONTANA

January 19, 1976
Job No. 69-147

All In Parts Per Million (-) Indicates Less Than Given Value

Sample Location	Depth, Ft.	Lab No.	Nitrate Nitrogen	Ammonia Nitrogen	Boron	Selenium	Molybdenum	Mercury	Zinc	Iron	Manganese	Copper	Cadmium	Lead	Nickel
50000N- 47000E	185-195 1B	52956	0.33	20.4	0.69	-0.02	0.30	0.014	5.22	33.3	2.54	1.69	0.02	3.3	1.06
	195-205 1B	52957	0.28	18.3	0.45	0.02	0.24	0.035	2.66	60.0	5.10	2.65	-0.01	2.8	0.93
	205-215 1B	52958	0.33	19.0	2.23	0.02	0.29	0.051	24.7	52.7	3.41	6.82	0.04	12.4	2.92
	215-225 1B	52959	0.28	15.0	0.60	-0.02	0.25	0.007	6.47	48.4	4.35	3.58	-0.01	4.2	0.92
	225-235 1B	52960	0.28	22.2	0.69	0.03	0.31	0.013	3.19	58.0	5.19	2.69	0.01	4.1	1.26

NORTHERN TESTING LABORATORIES, INC.
CONSULTING GEOTECHNICAL ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

CHEMICAL ANALYSIS OF TOPSOIL AND OVERBURDEN
AREA A, SECTION 32
53000N-48000E
WESTERN ENERGY COMPANY - COLSTRIP, MONTANA

January 19, 1976
Job No. 69-147

Depth, Feet	Lab No.	pH	Conductivity mmhos/cm	Saturation %	Calcium meq/Liter	Calcium meq/100 grams*	Magnesium meq/Liter	Magnesium meq/100 grams*	Sodium meq/Liter	Sodium meq/100 grams*	SAR	Texture**	Probable Subsurface Formation
0 - 5	52885	8.1	5.50	33.0	25.6	0.84	37.2	1.23	23.4	0.77	4.18	Silt Loam	Lt. Brown Topsoil
5 - 10	52886	8.3	5.10	37.3	23.6	0.88	30.2	1.13	25.4	0.95	4.90	Silty Clay Loam	Lt. Brown Clay
10 - 15	52887	8.0	3.70	41.4	13.4	0.55	21.4	0.87	17.7	0.73	4.24	Clay Loam	Lt. Brown Clay
15 - 17	52888	8.2	3.50	42.4	8.60	0.36	20.3	0.86	18.9	0.80	4.97	Silty Clay Loam	Lt. Brown Shale
17 - 19	52889	7.8	3.30	53.2	7.84	0.42	18.2	0.97	17.7	0.94	4.91	Silty Clay	Greenish-gray Shale
19 - 21	52890	7.4	3.20	68.9	9.05	0.62	16.9	1.16	16.6	1.14	4.61	Silty Clay	Lt. Brown Shale
21 - 26	52891	8.0	3.50	35.0	8.74	0.31	15.6	0.55	21.5	0.75	6.16	Silt Loam	Brown Shale
26 - 28	52892	8.0	2.60	68.8	3.99	0.27	12.8	0.88	16.0	1.10	5.52	Clay	Gray Shale
28 - 32	52893	8.3	2.25	31.6	3.52	0.11	8.31	0.26	16.3	0.52	6.70	Sandy Loam	Lt. Brown Sandstone
32 - 35	52894	8.0	2.70	51.0	3.99	0.20	9.63	0.49	18.1	0.92	6.94	Silty Clay Loam	Lt. Brown Shale
35 - 45	52895	7.6	3.70	4[illegible].9	8.27	0.39	18.3	0.86	21.4	1.00	5.87	Silty Clay	Gray Shale
45 - 55	52896	7.8	3.60	34.5	10.3	0.36	15.8	0.55	23.7	0.82	6.56	Silt Loam	Gray Shale
55 - 65	52897	8.0	2.80	31.9	5.93	0.19	8.72	0.28	19.3	0.62	7.13	Loam	Gray Sandy Shale
65 - 75	52898	7.9	3.50	80.3	7.80	0.63	13.6	1.09	23.8	1.91	7.28	Silt Loam	Gray Sandy Shale
75 - 85	52899	8.0	2.95	44.1	5.79	0.26	8.41	0.37	21.2	0.93	7.96	Silt Loam	Gray Shale
85 - 92	52900	7.2	4.50	64.4	18.9	1.22	18.3	1.18	25.4	1.64	5.89	Clay	Gray Shale
117 - 127 I.B.	52901	7.3	2.20	49.9	6.92	0.35	8.34	0.42	11.0	0.55	3.98	Silty Clay Loam	Dk. Gray Shale
127 - 137 I.B.	52902	7.3	3.00	29.9	15.0	0.45	15.7	0.47	10.2	0.31	2.60	Loam	Dk. Gray Sandy Shale
137 - 147 I.B.	52903	7.6	2.05	30.3	8.72	0.26	9.37	0.28	7.13	0.22	2.37	Sandy Loam	Gray Sandstone
147 - 157 I.B.	52904	7.3	1.90	30.8	6.80	0.21	7.81	0.24	8.59	0.26	3.18	Sandy Loam	Gray Sandstone
157 - 162 I.B.	52905	7.8	1.55	36.2	3.81	0.14	4.62	0.17	7.61	0.28	3.71	Silt Loam	Gray Shale

*Oven Dry Soil
**U. S. Department of Agriculture Soil Textural Triangle

NORTHERN TESTING LABORATORIES, INC.
CONSULTING GEOTECHNICAL ENGINEERS
Great Falls, Billings, Montana- Boise, Idaho - Gillette, Wyoming

CHEMICAL ANALYSIS OF TOPSOIL AND OVERBURDEN
AREA A, SECTION 32
54000N-47000E
WESTERN ENERGY COMPANY - COLSTRIP, MONTANA

January 19, 1976
Job No. 69-147

Depth, Feet	Lab No.	pH	Conductivity mmhos/cm	Saturation %	Calcium meq/Liter	Calcium meq/100 grams*	Magnesium meq/Liter	Magnesium meq/100 grams*	Sodium meq/Liter	Sodium meq/100 grams*	SAR	Texture**	Probable Subsurface Formation
0 - 2	52927	7.4	2.35	42.8	20.7	0.89	8.90	0.38	0.54	0.02	0.14	Silt Loam	Lt. Brown Topsoil
2 - 6	52928	7.6	7.10	74.3	22.7	1.69	57.1	4.24	37.6	2.79	5.95	Clay	Lt. Brown Topsoil
6 - 8	52929	8.1	7.00	51.6	22.0	1.14	47.7	2.46	40.8	2.11	6.91	Silt Loam	Brown Clay
8 - 11	52930	8.0	6.40	58.6	16.1	0.94	38.8	2.27	41.3	2.42	7.88	Silty Clay	Lt. Brown Clay
11 - 14	52931	7.8	6.25	40.6	24.5	0.99	41.3	1.68	34.7	1.41	6.05	Silt Loam	Lt. Brown Shale
14 - 17	52932	7.4	6.50	52.8	21.6	1.14	41.3	2.18	38.6	2.04	6.88	Clay Loam	Lt. Brown Shale
17 - 19	52933	7.8	5.95	55.2	19.7	1.02	30.6	1.59	38.8	2.02	7.74	Silty Clay Loam	Yellow-Brown Shale
19 - 21	52934	8.0	4.50	34.9	5.74	0.20	18.1	0.63	34.7	1.21	10.05	Silt Loam	Lt. Brown Shale
21 - 27	52935	7.9	4.60	32.7	9.20	0.30	11.2	0.37	39.4	1.29	12.34	Loam	Yellow-Brown Sandy Shale
27 - 31	52936	7.9	6.50	67.8	19.0	1.29	17.6	1.19	52.5	3.56	12.27	Silty Clay	Lt. Brown Shale
31 - 36	52937	8.1	3.60	86.7	2.54	0.22	2.60	0.23	38.3	3.32	23.89	Silty Clay	Greenish Gray Shale
36 - 46	52938	8.1	2.50	94.6	1.11	0.11	0.87	0.03	25.1	2.37	25.23	Silty Clay	Brownish Gray Shale
46 - 56	52939	8.3	2.20	100.1	0.65	0.07	0.47	0.05	22.4	2.24	29.93	Silty Clay	Brownish Gray Shale
56 - 66	52940	8.1	3.10	66.4	1.00	0.07	0.76	0.05	53.9	2.25	36.14	Loam	Lt. Brown Shale
66 - 76	52941	6.4	6.80	58.9	13.5	0.80	7.31	0.43	66.4	3.91	20.58	Clay	Brownish Black Sandy Shale
76 - 86	52942	8.2	2.20	54.8	1.54	0.08	0.85	0.05	22.5	1.23	20.58	Silty Clay Loam	Gray Shale
86 - 96	52943	8.2	2.70	35.2	0.37	0.03	0.64	0.02	30.7	1.08	35.33	Silty Clay	Gray Shale
96 - 106	52944	8.0	2.50	34.0	0.82	0.03	0.68	0.02	27.1	0.94	31.29	Silty Clay Loam	Gray Shale
106 - 116	52945	8.0	2.50	47.5	0.91	0.04	0.82	0.04	27.2	1.29	29.24	Silty Clay	Gray Shale
116 - 126	52946	8.0	2.80	44.1	1.30	0.06	1.14	0.05	28.6	1.26	25.89	Silty Clay Loam	Gray Shale
126 - 136	52947	7.6	3.25	43.7	3.19	0.14	2.53	0.11	31.2	1.36	18.45	Silty Clay Loam	Gray Shale
136 - 146	52948	7.9	2.70	30.0	1.32	0.05	1.53	0.05	26.2	0.79	20.24	Silt Loam	Gray Shale
146 - 156	52949	7.9	2.40	44.5	1.83	0.08	1.32	0.06	23.0	1.02	18.33	Silty Clay	Gray Shale
156 - 159	52950	6.3	5.40	60.0	14.3	0.86	8.33	0.50	48.2	2.89	14.33	Loam	Black Sandy Shale
159 - 190 I.B.	52951	7.0	1.70	53.4	4.26	0.23	4.31	0.23	11.9	0.64	5.75	Silt Loam	Gray Shale
190 - 200 I.B.	52952	7.4	1.65	42.9	4.90	0.21	5.31	0.23	9.22	0.40	4.08	Silt Loam	Gray Shale
200 - 210 I.B.	52953	7.9	1.15	30.2	2.69	0.02	3.15	0.03	6.09	0.06	3.56	Sandy Loam	Gray Sandstone
210 - 220 I.B.	52954	7.7	1.05	29.1	2.82	0.08	3.14	0.09	4.98	0.14	2.88	Sandy Loam	Gray Sandstone
220 - 230 I.B.	52955	7.7	1.25	28.6	3.32	0.10	3.23	0.09	7.10	0.20	3.92	Loamy Sand	Gray Sandstone

*Oven Dry Soil **U. S. Department of Agriculture Soil Textural Triangle

NORTHERN TESTING LABORATORIES, INC.
CONSULTING GEOTECHNICAL ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

January 19, 1976
Job No. 69-147

ANALYSIS OF TRACE ELEMENTS IN OVERBURDEN
AREA A, SECTION 32
WESTERN ENERGY COMPANY - COLSTRIP, MONTANA

All In Parts Per Million (-) Indicates Less Than Given Value

Sample Location	Depth, Ft.	Lab No.	Nitrate Nitrogen	Ammonia Nitrogen	Boron	Selenium	Molybdenum	Mercury	Zinc	Iron	Manganese	Copper	Cadmium	Lead	Nickel
53000N-46000E	0 - 5	52885	0.72	13.2	3.92	0.03	0.21	0.062	1.86	9.4	6.65	1.92	0.02	0.7	-0.01
	5 - 10	52886	-0.01	14.7	1.24	-0.02	0.20	0.052	1.92	14.7	12.2	1.48	0.03	1.4	-0.01
	10 - 15	52887	-0.01	15.4	0.69	0.02	0.23	0.027	0.90	28.2	10.7	1.27	0.01	2.3	0.09
	15 - 17	52888	-0.01	19.0	0.74	-0.02	0.30	0.045	1.74	16.6	5.43	2.89	0.01	2.1	0.04
	17 - 19	52889	-0.01	18.6	1.49	-0.02	-0.20	0.020	-0.01	43.5	7.06	3.30	0.04	9.6	0.47
	19 - 21	52890	-0.01	18.6	1.24	0.03	0.33	0.061	3.88	60.0	12.3	4.72	0.06	9.7	0.65
	21 - 26	52891	-0.01	18.3	1.74	-0.02	-0.20	0.028	1.57	17.8	3.70	1.49	0.02	1.0	-0.01
	26 - 28	52892	-0.01	19.7	0.99	-0.02	0.22	0.095	-0.01	56.0	5.51	6.16	0.06	18.6	1.83
B2-42	28 - 32	52893	-0.01	21.5	0.69	-0.02	-0.20	0.011	1.33	10.0	1.96	1.77	0.01	1.2	-0.01
	32 - 35	52894	0.22	67.5	0.54	-0.02	-0.20	0.041	1.31	71.0	8.50	3.27	0.03	4.4	0.17
	35 - 45	52895	0.22	21.1	0.84	-0.02	0.57	0.048	2.54	121.0	14.3	7.84	0.04	10.2	2.15
	45 - 55	52896	0.17	17.9	0.84	-0.02	0.60	0.058	2.48	66.0	4.76	4.57	0.04	5.1	1.65
	55 - 65	52897	0.11	22.9	1.49	-0.02	0.25	0.020	2.70	49.7	2.06	2.45	0.03	4.2	1.23
	65 - 75	52898	0.11	18.3	1.24	0.02	0.34	0.007	3.13	61.0	3.40	4.49	0.04	5.3	1.41
	75 - 85	52899	0.06	20.4	1.29	-0.02	0.32	0.032	4.76	68.0	5.67	5.65	0.04	4.7	1.57
	85 - 92	52900	0.11	31.5	1.84	-0.02	0.20	0.306	6.46	68.0	8.96	10.1	0.08	5.2	5.65
	1.B. 117 - 127	52901	0.33	21.1	1.14	0.02	0.20	0.105	28.1	50.0	1.50	5.50	0.06	9.3	1.53
	1.B. 127 - 137	52902	0.06	17.9	1.19	0.03	0.26	0.098	11.4	45.0	4.55	2.59	0.04	3.0	0.84
	1.B. 137 - 147	52903	0.06	18.3	0.50	-0.02	0.20	0.062	4.03	38.1	3.08	1.90	0.02	2.4	0.59
	1.B. 147 - 157	52904	0.17	16.1	1.14	-0.02	0.27	0.045	3.65	42.2	4.00	2.53	0.03	3.6	0.84
	1.B. 157 - 162	52905	0.17	19.7	2.13	0.02	0.38	0.045	3.59	63.0	5.16	4.65	0.04	4.8	1.37

NORTHERN TESTING LABORATORIES, INC.
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WESTERN ENERGY COMPANY - COLSTRIP, MONTANA

January 19, 1976
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All in Parts Per Million
(-) Indicates Less Than Given Value

Sample Location	Depth, Ft.	Lab No.	Nitrate Nitrogen	Ammonia Nitrogen	Boron	Selenium	Molybdenum	Mercury	Zinc	Iron	Manganese	Copper	Cadmium	Lead	Nickel
54000N-	0 - 2	52927	0.44	24.7	1.29	-0.02	-0.20	0.032	8.35	12.9	4.54	0.98	0.03	0.6	0.14
47000E	2 - 6	52928	0.22	15.8	1.59	0.04	0.26	0.026	1.52	37.6	2.69	2.98	0.07	3.1	0.67
	6 - 8	52929	0.67	23.6	1.69	-0.02	-0.20	0.021	3.15	13.4	3.68	0.98	0.03	1.6	0.04
	8 - 11	52930	3.00	19.7	1.93	0.02	-0.20	0.028	1.19	26.2	7.80	1.18	0.03	3.3	0.05
	11 - 14	52931	2.61	15.4	1.29	0.03	-0.20	0.019	0.98	11.7	2.54	1.33	0.04	1.4	0.11
	14 - 17	52932	2.89	24.0	1.19	0.02	0.33	0.102	1.52	41.0	1.78	2.38	0.06	2.9	0.52
	17 - 19	52933	3.66	20.8	1.09	0.05	-0.20	0.036	0.66	18.2	5.05	0.82	0.01	1.2	-0.01
	19 - 21	52934	2.44	20.9	1.29	0.02	-0.20	0.009	0.60	6.5	1.50	0.98	-0.01	1.4	-0.01
	21 - 27	52935	1.11	17.2	1.04	0.02	0.20	0.016	3.41	61.6	12.6	0.77	-0.01	0.5	0.05
	27 - 31	52936	0.44	23.3	1.49	-0.02	0.22	0.024	2.33	31.3	4.31	3.09	0.03	6.1	0.82
	31 - 36	52937	0.33	32.9	2.18	-0.02	-0.20	0.042	1.18	52.2	1.38	8.08	0.03	6.8	1.62
	36 - 46	52938	0.33	38.3	1.88	0.02	0.98	0.050	5.88	48.8	6.79	5.37	0.04	5.2	2.47
	46 - 56	52939	0.39	44.4	1.84	0.03	0.82	0.051	5.22	50.0	7.28	2.38	0.04	6.4	2.76
	56 - 66	52940	0.22	30.1	1.29	-0.02	0.54	0.023	4.78	69.0	9.06	1.67	0.03	2.8	1.60
	66 - 76	52941	0.44	26.9	6.99	-0.02	0.43	0.021	3.20	85.0	6.37	2.51	0.04	7.5	2.44
	76 - 86	52942	0.50	21.8	1.84	0.02	0.58	0.033	2.85	52.0	5.22	3.16	-0.01	8.4	1.10
	86 - 96	52943	0.28	23.3	1.29	-0.02	0.27	0.031	1.72	67.0	5.86	2.23	-0.01	15.5	0.60
	96 - 106	52944	0.28	25.4	1.29	0.02	0.61	0.021	3.42	64.0	8.52	1.54	0.01	5.9	1.11
	106 - 116	52945	0.22	24.0	2.03	0.04	0.39	0.037	1.64	102.0	15.7	2.90	-0.01	3.6	0.98
	116 - 126	52946	0.22	26.9	1.34	0.04	0.47	0.060	2.80	62.0	9.69	2.09	-0.01	2.6	1.04
	126 - 136	52947	0.33	25.1	1.19	0.02	0.71	0.087	2.23	90.0	15.9	2.30	-0.01	5.7	1.47
	136 - 146	52948	0.28	19.7	0.50	-0.02	0.37	0.036	2.51	63.0	8.01	1.41	-0.01	3.2	1.13
	146 - 156	52949	0.50	22.9	1.64	0.02	0.89	0.045	5.52	69.0	10.6	3.89	0.04	11.1	2.52
	156 - 159	52950	0.50	31.5	11.9	0.04	0.27	0.108	5.37	92.0	16.9	6.44	0.23	4.9	2.03
1.B.	183 - 190	52951	0.44	24.7	2.88	0.02	0.23	0.008	9.8[illegible]	57.0	7.33	1.75	0.02	6.3	1.10
1.B.	190 - 200	52952	0.39	18.6	1.54	-0.02	0.28	0.030	5.68	82.0	5.56	1.79	0.01	3.9	0.30
1.B.	200 - 210	52953	0.28	19.0	1.34	0.03	0.21	0.012	4.48	22.7	1.87	1.47	-0.01	1.9	0.33
1.B.	210 - 220	52954	0.22	17.9	1.39	-0.02	0.27	0.010	2.57	20.4	2.15	1.00	-0.01	1.6	0.43
1.B.	220 - 230	52955	0.17	17.9	1.49	-0.02	0.25	0.012	8.23	21.8	2.64	0.78	-0.01	1.7	0.35

NORTHERN TESTING LABORATORIES, INC.
CONSULTING GEOTECHNICAL ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

CHEMICAL ANALYSIS OF TOPSOIL AND OVERBURDEN
AREA A SECTION 32
55000N 48000E
WESTERN ENERGY COMPANY - COLSTRIP, MONTANA

January 19, 1976
Job No. 69-147 .

B2-44

Depth, Feet	Lab No.	pH	Conductivity mmhos/cm	Saturation %	Calcium meq/Liter	Calcium meq/100 grams*	Magnesium meq/Liter	Magnesium meq/100 grams*	Sodium meq/Liter	Sodium meq/100 grams*	SAR	Texture**	Probable Subsurface Formation
0 - 8	52906	8.0	0.65	36.0	0.87	0.03	1.06	0.04	6.17	0.22	6.28	Sandy Clay Loam	Dk. Brown Topsoil
8 - 13	52907	8.2	8.75	32.0	22.4	0.72	37.5	1.20	67.2	2.15	12.28	Sandy Loam	Dk. Brown Clay
13 - 17	52908	8.2	8.00	34.7	22.7	0.79	33.3	1.16	62.0	2.15	11.72	Loam	Brown Sandy Shale
17 - 24	52909	7.9	5.30	33.7	8.36	0.28	21.0	0.71	42.4	1.43	11.07	Loam	Brown Sandy Shale
24 - 29	52910	7.5	4.30	44.4	9.48	0.42	18.2	0.81	31.8	1.41	8.55	Silty Clay Loam	Gray Shale
29 - 32	52911	8.2	3.10	37.7	4.03	0.15	5.99	0.23	28.8	1.09	12.87	Silt Loam	Brown Shale
32 - 35	52912	8.1	3.20	53.4	3.59	0.19	9.59	0.51	26.1	1.39	10.17	Clay	Gray Shale
35 - 42	52913	8.2	2.60	30.7	2.99	0.09	5.51	0.17	23.2	0.71	11.25	Loam	Brown Sandy Shale
42 - 45	52914	8.1	3.40	34.2	3.84	0.13	8.99	0.31	26.7	0.91	10.54	Silt Loam	Dk. Brown Shale
45 - 47	52915	7.9	2.70	32.0	3.24	0.10	4.95	0.16	21.8	0.70	10.77	Sandy Clay Loam	Gray Sandstone
47 - 51	52916	8.1	2.80	60.9	2.50	0.15	5.45	0.33	23.7	1.44	11.89	Clay	Gray Shale
51 - 55	52917	8.3	3.10	35.1	2.43	0.09	3.25	0.11	29.7	1.04	17.62	Silt Loam	Brown Shale
55 - 57	52918	7.3	4.60	54.8	12.1	0.66	14.1	0.77	35.2	1.93	9.73	Silty Clay	Gray Shale
57 - 64	52919	8.4	3.80	28.6	2.69	0.08	2.64	0.08	41.0	1.17	25.11	Loam	Brown Sandy Shale
64 - 74	52920	7.9	3.50	42.5	2.45	0.11	2.35	0.10	36.0	1.53	23.14	Silty Clay Loam	Gray Shale
105 - 110 1.B.	52921	7.4	2.85	45.5	3.05	0.14	2.07	0.09	27.8	1.26	17.38	Silty Clay	Dk. Gray Shale
110 - 120 1.B.	52922	7.1	3.60	34.4	8.94	0.31	6.67	0.23	31.1	1.07	11.13	Silt Loam	Dk. Gray Shale
120 - 130 1.B.	52923	7.5	3.70	31.7	7.00	0.22	5.48	0.17	31.9	1.01	12.77	Loam	Dk. Gray Sandy Shale
130 - 140 1.B.	52924	7.8	2.00	26.9	4.58	0.12	3.15	0.08	14.4	0.39	7.32	Sandy Loam	Gray Sandstone
140 - 150 1.B.	52925	7.5	1.35	26.9	3.58	0.10	3.35	0.09	7.75	0.21	4.16	Sandy Loam	Gray Sandstone
150 - 160 1.B.	52926	7.3	1.60	30.0	3.64	0.11	3.30	0.10	10.3	0.31	5.53	Sandy Loam	Gray Sandstone

*Oven Dry Soil
**U. S. Department of Agriculture Soil Textural Triangle

NORTHERN TESTING LABORATORIES, INC.
CONSULTING GEOTECHNICAL ENGINEERS
Great Falls, Billings, Montana - Boise, Idaho - Gillette, Wyoming

ANALYSIS OF TRACE ELEMENTS IN OVERBURDEN
AREA A, SECTION 32
WESTERN ENERGY COMPANY - COLSTRIP, MONTANA

January 19, 1976
Job No. 69-147

All In Parts Per Million (-) Indicates Less Than Given Value

[illegible]	Depth, Ft.	Lab No.	Nitrate Nitrogen	Ammonia Nitrogen	Boron	Selenium	Molybdenum	Mercury	Zinc	Iron	Manganese	Copper	Cadmium	Lead	Nickel
[illegible]	0 - 8	52906	0.44	18.6	1.74	-0.02	-0.20	0.027	2.58	9.3	9.54	2.57	0.04	1.3	0.33
[illegible]	8 - 13	52907	0.17	19.3	1.54	-0.02	0.49	0.028	2.60	16.6	33.1	4.35	0.03	0.9	0.19
	13 - 17	52908	0.11	22.6	1.19	0.02	0.21	0.057	1.96	11.6	19.0	3.04	0.03	1.3	0.22
	17 - 24	52909	0.11	23.6	0.89	-0.02	0.33	0.055	1.34	7.8	5.46	2.11	0.02	0.9	0.08
	24 - 29	52910	0.17	20.8	1.29	-0.02	0.58	0.087	1.93	55.0	5.98	2.36	0.05	6.0	1.03
	29 - 32	52911	0.06	21.8	0.60	-0.02	-0.20	0.041	2.51	8.9	3.98	4.34	0.02	0.9	0.06
	32 - 35	52912	0.17	27.9	1.19	0.03	0.21	0.078	2.79	53.3	4.24	2.97	0.05	11.9	1.17
	35 - 42	52913	0.06	19.7	1.54	-0.02	-0.20	0.028	0.63	25.5	5.75	0.65	0.02	1.2	0.10
	42 - 45	52914	0.11	22.2	1.49	-0.02	0.42	0.058	2.25	40.6	7.63	1.64	0.03	2.4	0.38
	45 - 47	52915	0.11	26.9	2.03	-0.02	0.26	0.036	3.26	73.0	6.91	1.61	0.02	4.6	0.73
	47 - 51	52916	0.22	25.4	1.34	-0.02	0.52	0.071	-0.01	87.0	10.0	3.13	0.04	5.2	1.75
	51 - 55	52917	0.11	24.7	0.74	-0.02	0.20	0.013	2.25	21.8	4.30	3.40	0.03	3.4	0.17
	55 - 57	52918	0.28	25.4	1.29	0.02	0.49	0.150	2.80	72.0	16.4	3.47	0.05	8.2	1.80
	57 - 64	52919	0.28	20.4	0.84	-0.02	0.48	0.038	2.00	19.6	6.60	2.55	0.02	0.5	0.04
	64 - 74	52920	0.28	21.1	1.14	-0.02	0.46	0.055	3.07	76.0	12.3	2.73	0.05	5.6	1.41
1.B.	105 - 110	52921	0.44	26.9	4.12	-0.02	2.50	0.180	9.14	30.1	3.40	3.06	0.05	10.3	0.87
1.B.	110 - 120	52922	0.67	23.6	1.64	0.03	0.47	0.089	3.45	70.0	5.62	1.69	0.05	4.7	1.24
1.B.	120 - 130	52923	0.22	24.3	1.59	0.03	0.46	0.055	9.50	65.0	7.60	1.49	0.03	4.4	0.87
1.B.	130 - 140	52924	0.11	27.6	0.79	-0.02	0.24	0.025	2.00	22.4	2.50	0.83	0.02	1.9	0.47
1.B.	140 - 150	52925	0.17	26.1	0.89	-0.02	0.23	0.024	4.92	35.3	3.26	2.01	0.02	3.3	0.75
1.B.	150 - 160	52926	0.22	20.4	1.64	0.02	0.20	0.059	3.75	31.9	3.52	1.73	0.03	3.1	0.49

STATE

OVERBURDEN AND INTERBURDEN
ANALYSIS

for

AREA E-2

as required by

THE STRIP MINE COAL CONSERVATION ACT

and

PURSUANT RULES AND REGULATIONS

Chapter 220

Session Laws of Montana, 1973

Prepared by

MONTANA TESTING LABORATORIES, INC.

for

WESTERN ENERGY COAL COMPANY

Raymond T. Choriki Soils Specialist

1/74

PROJECT TITLE: OVERBURDEN AND INTERBURDEN ANALYSIS AS RELATED TO REVEGETATION PURPOSES IN COLSTRIP, MONTANA

JUSTIFICATION:

Revegetation can be a problem from soils containing some undesirable characteristics such as high sodium (SAR), high salt, high percentage of clay, structure that causes very little intake, and low fertility. This analysis was conducted to evaluate the potential problem that may occur from overburden and interburden material during strip mining operations. This was conducted to evaluate the problems that may exist prior to mining operations above the Rosebud and between the McKay and Rosebud coal seams.

METHODS AND MATERIALS:

1. Sample Collection

   Six sets of drill core samples for Area E-2 were submitted by Western Energy Coal Company; N48 E64, N49 E64, N47 E65, N50 E62.5, N46 E66.5, N52 E62, N47,850 E59,150, N49,600 E59,100, and N51,300 E60,200. These were taken at various intervals depending upon the texture and color.

2. Sample Preparation

   Samples were air dried and split in half. The first half will be kept in the plastic bag. The second half was prepared for analysis as follows:

   1. 500 grams screened for mechanical analysis (9 mesh).
   2. Screen 12 mesh and split samples - ½ for green house study
      ½ for lab analysis
   3. Sample for laboratory analysis screened to 20 mesh size and kept for analysis. Sample for green house can be used for weathering also if desired. Because large quantities of samples are required for SAR and mechanical analysis, it may be necessary to analyze SAR and use the same sample for mechanical analysis.
   4. 100 grams was sent to U. S. Testing Lab for trace elements.

5. Mechanicalanalysis screen size 9 mesh.

3. Chemical Analysis

1. pH and conductivity - saturated paste.
2. Sodium Adsorption Ratio.
3. Sodium Exchange Potential (calculate if necessary- need CEC also). This has the same interpretation values as SAR.
4. Micro Analysis

   Copper

   Iron (chelatable DPTA)

   Manganese

   Zinc

   Exchangeable Ammonium

   Nitrate

   Cadmium'

   Lead

   Mercury

   Selenium

   Molybdenum

   Boron

   Nickel
5. CEC
6. Mechanical Analysis
7. Plant Growth Test (if deemed necessary)
   - a) 500 grams of air dried soil or less if soil not available.
   - b) Add 50 ppm P as concentrated super phosphate.
   - c) Add 50 ppm N as NH_4NO_3 on weekly basis.
   - d) Seeded to Horsford barley 6 seeds/pot.
   - e) Water with distilled water to .33 bar or field capacity and maintain weight daily , and harvest(dry weight,tillers & stand).

RESULTS AND DISCUSSION:

Description of Soil as Submitted by Western Energy

Hole # N48 E64 Area E-2

Lab No.	Depth in Feet	Soil Description
7094	0-10	Light brown sandstone, fine grained
7095	10-20	Light brown sandstone, fine grained
7096	20-30	Light brown sandstone, fine grained
7097	30-40	Light brown sandstone, fine grained
7098	40-43	Light brown sandstone, fine grained
7099	43-53	Gray sand stone, fine grained
7100	53-63	Gray sandstone, fine grained
	63-88	Coal
7101	88-98	Gray shale, fine grained
7102	53-102	Gray shale, fine grained

Hole #49 E64 Area E-2

Lab No.	Depth in Feet	Soil Description
7117	0-10	Light brown sand, fine grained
7118	10-20	Light brown sand, fine grained
7119	20-30	Light brown sand, fine grained
7120	30-40	Light gray sand, fine grained
7121	40-45	Brown sand, fine grained
7122	45-55	Gray sand, fine texture
7123	55-65	Gray silt shale
7124	65-75	Gray silt shale
7125	75-85	Light gray silt shale, fine texture
7126	85-87	Light gray silt shale
	87-112	Rosebud Coal
7127	112-122	Gray silt shale
7128	122-124	Gray silt shale
	124+	McKay Coal

Hole # N47 E65 Area E-2

Lab No.	Depth in Feet	Soil Description
7129	0-10	Light brown top soil
7130	10-20	Light brown sand, fine grained
7131	20-30	Light brown sand, fine grained
7132	30-40	Light brown sand, fine grained
7133	40-46	Gray silt shale
7134	46-56	Gray silt shale
7135	56-65	Gray silt shale
	65-90	Coal
7136	90-100	Gray silt shale, hard
	100 +	Coal

Hole # N50 E62.5 Area E-2

7137	0-10	Light brown top soil
7138	10-20	Light brown soil
7139	20-30	Light brown sandstone, fine grained
7140	30-35	Light brown sandstone, fine grained
7141	35-45	Light gray silt, fine texture
7142	45-55	Light gray silt shale
7143	55-62	Light gray silt shale
7144	62-87	Coal
7144	87-97	Dark gray silt shale
7145	97-100	Dark gray silt shale
	100 +	Dark gray silt shale

Hole # N52 E62 Area E-2

Lab No.	Depth in Feet	Soil Description
7146	0-10	Light brown top soil, very fine grain
7147	10-20	Light brown sand, very fine grain
7148	20-30	Light brown sand, coarse grain
7149	30-40	Light brown soft sandstone
7150	40-42	Light grayish brown sandstone, fine texture
7151	42-52	Light gray silt shale, hard
7152	52-62	Light gray silt shale, hard
7153	62-72	Light gray silt shale, very hard
7154	72-80	Light gray sand, mixed
	80-106	Coal
7155	106-116	Light gray silt shale
7156	116-126	Gray silt shale
	126 +	Coal

Hole # N46 E66 Area E-2

7157	0-10	Light brown sand, fine grained
7158	10-20	Brown sandstone, very fine grained
7159	20-30	Brown sandstone, very fine grained
7160	30-38	Brown sandstone, very fine grained
7161	38-44	Brown sandstone, very fine grained
7162	44-54	Gray silt shale
7163	54-64	Gray silt shale
7164	64-74	Gray silt shale, hard
7165	74-78	Gray silt shale, hard
	78-105	Coal
7166	105-115	Gray silt shale, hard
7167	115-118	Gray silt shale, hard
	118 +	Coal

Description of Soil as Submitted by Western Energy

Hole # N47,850 E59,150

Lab No.	Depth in Feet	Soil Description
8184	0-5	Light brown clay loam, top soil
8185	5-10	Light gray-brown clay loam, top soil
8186	10-15	Light grayish brown clay loam
8187	15-20	Light grayish brown clay loam
8188	20-25	Light brown sandstone, fine grained
8189	25-30	Light reddish brown sandstone, fine grained
8190	30-35	Light grayish brown sandstone, fine grained
8191	35-40	Gray sand stone, coarse
8192	40-45	Gray silt stone shale
8193	45-50	Dark gray silt stone shale
8194	50-55	Gray silt stone shale
8195	55-60	Gray silt stone shale
[illegible]	60-84	
8196	84-90	Gray clay, intermittant coal
8197	90-95	Light gray clay, some coal
8198	95-100	Light gray clay
8199	100-105	Gray clay mixed with coal
8200	105-110	Gray clay mixed with coal

Hole # N49,600 E59,100

8201	0-5	Reddish brown fine sand, top soil
8202	5-10	Reddish brown sandstone, fine grained
8203	10-15	Grayish brown sandstone, fine grained
8204	15-20	Grayish brown sandstone, fine grained
8205	20-25	Grayish brown sandstone, fine grained
8206	25-30	Grayish brown sandstone, fine grained
8207	30-35	Grayish brown sandstone, fine grained
8208	35-40	Grayish brown sandstone, fine grained
8209	40-45	Grayish brown sandstone, fine grained
8210	45-50	Grayish brown sandstone
8211	50-55	Gray-brown silty shale
8212	55-60	Gray-brown silty shale
8213	60-65	Gray-brown silty shale
8214	65-70	Reddish gray silty shale
8215	70-75	Reddish gray silty shale
8216	75-80	Reddish gray silty shale
8217	80-82	Reddish gray silty shale mixed with coal
Coal	82-105	[illegible]
8218	105-110	Gray sandstone, fine grained, with coal present
8219	110-115	Light gray sandstone with coal present
8220	115-120	Light gray sandstone with coal present
8221	120-125	Light gray sandstone with coal present

Hole # N51,300 E60,200

Lab No.	Depth in Feet	Soil Description
8222	0-5	Very fine reddish gray sand, top soil
8223	5-10	Reddish soil with gray clay, top soil
8224	10-15	Light reddish clay
8225	15-20	Soft grayish brown sandstone, fine grained
8226	20-25	Soft grayish brown sandstone, fine grained
8227	25-30	Soft grayish brown sandstone, fine grained
8228	30-35	Soft light brown sandstone, fine grained
8229	35-40	Soft reddish brown sandstone, fine grained
8230	40-45	Gray silty stone shale
8231	45-50	Gray silty stone shale
8232	50-55	Grayish red , very fine sand
8233	55-60	Light grayish-red sandstone, very fine grained
8234	60-65	Light grayish brown sandstone, very fine grained
8235	65-70	Gray silty clay
8236	70-75	Gray silty clay
8237	75-80	Gray silty clay
8238	80-85	Gray silty clay
Coal	85-111	
8239	111-115	Gray silt stone with coal mixed
8240	115-120	Gray silty stone with coal mixed
8241	120-125	Gray silt stone shale
8342	125-130	Gray silt stone shale
8243	130-132	Gray silt stone shale
Coal	132-164	
8244	164-169	Hard gray silt stone shale
8245	169-174	Hard gray silt stone shale

Hole # N48 E04 (Tables 1, 2 & 3)

pH is a measure of hydrogen ion activity. Most Montana soils have a pH between 6 and 8.2. pH less than 6 will increase solubility of some metals and present a nutrient imbalance while soil above 8.2 may indicate high soluble carbonates, low solubility of calcium and magnesium salts, and high sodium.

pH exceeded 8.2 on 30-40' increment. Sodium Adsorption Ratio values were very low however at that depth. Should not cause any sodium related problems.

Electrical Conductivity was very low and should not restrict plant growth.

Sodium Adsorption Ratio was well below 10-12 values and should have no problem on structural stability and permeability.

Textural clalles of the area are sandy clay loam, sandy loam, loam and clay loam. Clay content is between 12 to 28% on all increments taken (0-102') and should maintain desirable texture for plant growth.

Nitrogen as nitrate was very low on all samples. Exchangeable ammonium was present with 10-15 ppm at various depths. Since ammonium ions can be converted to nitrate with appropriate soil bacteria, it can be a threat to underground water tables or surface run off with streams, if not properly used by plants. Nitrogen requirement for grass establishment should be adjusted during year of establishment.

Nitrification of Exchangeable Ammonium in soil buried at lower depths should be very slow because of sterile environment, and low oxygen and moisture; anticipate rapid conversion to nitrate near the surface. It is unlikely that exchangeable ammonium would leach readily because of its nature.

DTPA chelatable zinc, manganese, iron and copper were not extremely high. Layer immediately above the coal seems to have a higher level (4.5 ppm) of chelatable copper.

Hot water extractable Selenium was well below 1.0 ppm at all depths and should not restrict growth.

Mercury (acid extractable) was well below 500 ppb level. The layer immediately above the Rosebud coal was unusually higher than the remaining layers with 240 ppb. It is doubtful that this would restrict plant growth and development.

Boron, cadmium and molybdenum are well below levels of anticipated problems and should not restrict plant growth.

Nickel above and below the coal seam was above 1.0 ppm but should not restrict plant growth.

Lead exceeded 5 ppm near the coal seam and should not be permitted to be placed near the surface.

SUMMARY

1. Lead exceeded 5 ppm above the coal seam and requires special handling of soil.
2. Soluble salts were very low and anticipate very little problem or none on all other depths.

Table ___ Chemical Properties of Soil and Overburden Materials Associated with Coal Areas. Western Energy Coal Company. Area E-2

Hole # N48 E64

Lab No.	Depth feet	pH Paste	Sat'n. %	Elect. Cond. mmhos/cm.	Saturated Extract Cations Ca	Mg	Na	SAR
					- - - - - - meq/liter	- - - - - -		
7094	0-10	8.0	23.2	0.33	3.9	1.6	2.8	1.72
7095	10-20	8.2	30.3	0.5	3.9	3.3	3.6	2.05
7096	20-30	8.1	24.5	0.33	3.6	3.9	4.4	2.25
7097	30-40	8.4	26.3	0.3	2.1	1.4	2.4	1.81
7098	40-43	8.1	25.8	0.43	4.8	5.3	3.0	1.34
7099	43-53	8.2	26.0	0.73	5.2	6.2	4.3	1.47
7100	53-63	7.8	40.5	0.8	7.5	7.1	2.9	1.09
Coal Seam	63-88							
7101	77-98	8.0	27.7	0.87	6.3	8.3	3.1	1.14
7102	98-102	7.7	28.5	2.3	10.8	11.9	3.5	1.03

Table ___ Results of Mechanical Analysis (Hydrometer Method) with Nitrates and Micro Nutrients(Zinc, Iron, Copper, and Manganese) for Overburden Samples. Western Energy Coal Company. Area E-2

Hole # N48 E64

Lab No.	Depth feet	% Clay	% Silt	% Sand	Texture	NO_3	Zn	Fe	Cu	Mn
7094	0-10	18.2	14.3	67.5	SL	0.50	1.4	4.6	1.2	2.0
7095	10-20	24.4	22.0	53.6	SCL	0.50	0.2	4.4	1.4	1.8
7096	20-30	14.6	19.6	65.8	SL	3.75	1.1	6.3	1.4	2.8
7097	30-40	12.0	10.4	77.6	SL	2.50	0.2	3.9	1.4	2.8
7098	40-43	21.2	24.6	54.2	SCL	0.25	17.5	16.6	1.8	7.6
7099	43-53	12.6	13.6	73.8	SL	0.50	2.9	18.4	2.0	4.0
7100	53-63	28.4	38.8	32.8	CL	1.25	13.8	22.9	4.5	4.8
Coal Seam	63-88									
7101	83-98	22.0	36.4	41.6	L	0.25	3.2	7.2	2.3	4.0
7102	98-102	15.6	40.0	44.4	L	0.25	16.0	9.8	2.4	4.8

Table ___ Chemical Analysis of Overburden Samples. Western Energy . Area E-2.

Hole # N48 E64

Lab No.	Depth feet	Ex.NH_4 (ppm)	Se (ppm)	Hg (ppb)	B (ppm)	Pb (ppm)	Cd (ppm)	Ni (ppm)	Mo (ppm)	CEC meq/100gr
7094	0-10	10.0	<0.5	10.0	0.2	0.8	0.1	0.2	0.07	5.0
7095	10-20	11.0	<0.5	40.0	0.4	1.0	0.1	0.2	0.06	5.3
7096	20-30	11.0	<0.5	10.0	0.4	0.9	0.1	0.2	0.04	3.5
7097	30-40	12.0	<0.5	40.0	0.3	0.8	0.1	<0.1	0.03	2.5
7098	40-43	12.0	<0.5	10.0	0.5	2.2	0.1	0.4	0.03	3.5
7099	43-53	12.0	<0.5	40.0	0.5	2.3	0.1	0.6	0.06	2.0
7100	53-63	13.0	<0.5	240.0	1.3	6.4	0.2	1.9	0.09	7.5
Coal Seam	63-88									
7101	88-98	13.0	<0.5	40.0	0.7	4.2	0.2	1.1	0.11	2.7
7102	98-102	15.0	<0.5	80.0	1.1	2.3	0.2	0.8	0.11	3.1

HOLE # N49 E64 (Table 4,5,6)

pH is between 6 and 8.2 on all depths except 10-30' and 40-45'. These depths contain higher pH but should not limit plant growth if sodium is low and fertilizer supplemented.

Soluble salts are well below expected level of anticipated problems. Soluble salts were 1.53 mmhos/cm and lower throughout the depth. This should not restrict plant growth and development.

Sodium Adsorption Ratio is very low and should not cause any soil related problem.

Textural classes of the area are sandy loam, loamy sand, loam, sandy clay loan and silty clay loam. Texture remains favorable and may help leach the salt from the shale to a lower depth. At 85-87' the fine material accummulated and should not be allowed to be left on the surface.

Nitrate Nitrogen is very low. Exchangeable ammonium is repeatedly high (above 10 ppm). This should help relieve the need of nitrogen in later years as this becomes available.

Chelatable Zinc, Manganese, Iron and Copper are well below expected toxic levels. The copper above the Rosebud layer is higher than the normal level found in soil.

Selenium is very low (less than .5 ppm) and should not restrict any plant growth.

Mercury (Hg) is low and should not restrict plant growth.

Boron is well below 3 ppm and should not restrict plant growth.

Molybdenum is low and should not restrict plant growth.

Cadmium is low and should not restrict plant growth.

Nickel exceed 1.0 ppm between 45-124 feet. At least this is a suggested level that may cause some problems and should be kept at lower depth. It seems to be higher, above and below the coal layer.

Lead exceed 5.00 ppm between 65-75 feet, 85-87 feet, and 112-122 feet. This may cause some problem in plant growth and development.

SUMMARY

1. Nickel exceeded 1.0 ppm between 45-124 feet and may restrict normal plant growth.development.

2. Lead exceeds 5.0 ppm between 65-75', 85-87', and 112-122' and may restrict normal plant growth and development.

3. Anticipate no problem in relation to texture to soil physical problem, as texture, crusting, low permeability, or other chemically related problems.

Table [illegible] Chemical Properties of Soil and Overburden Materials Associated with Coal Areas. Western Energy Coal Company. Area E-2

Hole # N49 E64

Lab No.	Depth feet	pH Paste	Sat'n. %	Elect. Cond. mmhos/cm.	Saturation Extract Cations Ca	Mg	Na	SAR
					- - - - - -	meq/liter	- - - - - -	
7117	0-10	8.1	28.9	0.2	1.1	3.1	3.4	2.32
7118	10-20	8.6	26.0	0.97	6.3	8.7	4.9	1.79
7119	20-30	8.3	32.6	1.33	8.0	10.1	3.0	3.01
7120	30-40	8.0	26.5	1.3	10.4	9.3	4.9	1.56
7121	40-45	8.3	25.0	0.47	2.2	5.0	2.5	1.33
7122	45-55	8.1	29.8	0.2	6.0	7.2	2.2	2.45
7123	55-65	8.1	31.6	1.1	3.9	5.6	2.3	1.05
7124	65-75	8.1	31.3	0.83	4.8	7.1	3.6	1.43
7125	75-85	8.0	26.7	1.53	9.4	11.7	5.6	1.08
7126	85-87	7.9	59.4	1.5	10.1	11.2	5.4	1.67
Coal Seam	87-112							
7127	112-122	8.0	32.9	1.17	5.0	4.2	7.8	3.65
7128	122-124	8.0	31.8	1.7	8.5	6.3	11.7	4.30

Table 5 Results of Mechanical Analysis (Hydrometer Method) with Nitrates and Micro Nutrients (Zinc, Iron, Copper, and Manganese) for Overburden Samples. Western Energy Coal Company. Area E-2

Lab No.	Depth Feet	% Clay	% Silt	% Sand	Texture	NO_3	Zn	Fe	Cu	Mn
7117	0-10	10.8	7.4	81.8	SL	0.25	3.0	3.0	1.6	2.4
7118	10-20	10.4	6.6	83.0	LS	0.25	3.2	1.4	2.0	2.0
7119	20-30	7.2	6.4	86.4	LS	0.25	13.0	2.4	0.9	3.2
7120	30-40	12.4	13.0	74.6	SL	0.25	2.5	2.0	1.4	2.8
7121	40-45	10.0	13.0	77.0	SL	0.25	16.0	3.8	1.4	5.8
7122	45-55	15.2	36.8	48.0	L	0.25	3.9	30.0	2.0	7.0
7123	55-65	22.4	27.2	50.4	SCL	0.25	4.3	50.0	1.4	7.4
7124	65-75	20.4	32.0	47.6	L	0.25	2.5	95.0	1.8	9.2
7125	75-85	16.8	31.6	51.6	L	0.25	9.0	22.9	1.6	4.0
7126	85-87	48.8	32.6	18.6	SiCL	0.25	7.5	30.0	5.6	3.2
Coal Seam	87-112									
7127	112-122	26.0	25.6	48.4	SCL	0.25	14.5	8.4	2.6	3.4
7128	122-124	18.0	27.6	54.4	SL	0.25	16.8	9.3	2.4	4.4

Table 6 Chemical Analysis of Overburden Samples. Western Energy. Area E-2.

Hole # N49 E64

Lab No.	Depth feet	Ex.NH$_4$ (ppm)	Se (ppm)	Hg (ppb)	B (ppm)	Pb (ppm)	Cd (ppm)	Ni (ppm)	Mo (ppm)	CEC meq/100gr
7117	0-10	24.0	0.5	6.0	0.2	1.3	0.2	0.1	1.2	16.5
7118	10-20	20.0	0.5	6.0	0.5	1.3	0.1	0.1	0.11	5.0
7119	20-30	17.0	0.5	10.0	0.1	1.4	0.1	0.1	0.07	19.0
7120	30-40	15.0	0.5	6.0	0.2	1.9	0.1	0.2	0.1	2.7
7121	40-45	21.0	0.5	6.0	0.2	2.1	0.2	0.3	0.18	23.0
7122	45-55	36.0	0.6	16.0	0.3	4.0	0.2	1.2	0.36	2.7
7123	55-65	45.0	0.5	28.0	0.3	4.8	0.2	1.6	0.40	2.7
7124	65-75	45.0	0.5	16.0	0.4	5.7	0.2	1.9	0.39	2.7
7125	75-85	24.0	0.5	30.0	0.6	4.1	0.2	1.6	0.26	2.0
7126	85-87	30.0	0.5	82.0	2.0	5.1	0.2	1.8	0.26	2.0
Coal Seam	87-112									
7127	112-122	30.0	0.5	28.0	1.2	6.8	0.2	2.8	0.74	2.7
7128	122-124	29.0	0.5	140.0	0.8	3.3	0.2	1.4	0.65	1.7

82-60

HOLE # N47 E65 (Table 7, 8, & 9)

pH is unusually high on the upper 40 feet. This level may indicate high carbonate or sodium and supplemental fertilizer becomes important.

The Soluble Salts on surface 10' were moderately high and should not be permitted to be left on the surface.
The lower depth remain satisfactory, and should not restrict plant growth and establishment.

Sodium Adsorption Ratio is exceptionally high on the surface 10 feet. SAR values below 10' seem to be low in sodium in relation to calcium and magnesium.

Texture of this hole seems quite coarse (sandy loam and loamy sand). The salt and sodium should leach readily and prevent accumulation near the surface.

Nitrate Nitrogen is very low. Exchangeable ammonium was present throughout the hole and concentration varied from 8-32 PPM. This is a source of nitrogen and nitrogen requirement should be adjusted at seeding.
Chelatable Zinc, Manganese, Iron and Copper were below the anticipated level to decrease plant production. For some reason, the zinc content was quite a bit higher than normally found on the surface soil in the 0-10' increment.

Selenium was very low, below 1.0 ppm, and should not restrict growth.

Mercury was all below 40 ppb and well below expected toxic ity level of 500 ppb.

Boron is low and should not restrict growth.

Lead DTPA chelatable lead between 1-5 should be looked at with suspicion. Depth between 46-60 contain 3.6 to 4.0 ppm lead.

Cadmium is well below expected toxicity level of 1.00 ppm.

Nickel exceeds toxic level at depths just below and just above the coal seam at depths of 56-65' and 90-100', and may restrict plant growth.

8

Table ___ Chemical Properties of Soil and Overburden Materials Associated with Coal Areas. Western Energy Coal Company. Area E-2

Hole #N47 E65

Lab No.	Depth	pH	Sat'n.	Saturated Extract				
				Elect.	Cations			
		Paste		Cond.	Ca	Mg	Na	SAR
	feet		%	mmhos/cm.	- - - - - meq/liter	- - - - - - -		
7129	0-10	8.3	28.9	20.57	27.5	75.0	75.2	10.50
7130	10-20	8.5	23.0	13.43	16.5	25.0	18.0	3.95
7131	20-30	8.4	29.5	0.67	4.8	8.0	3.2	0.69
7132	30-40	8.4	30.9	0.5	8.3	10.8	2.5	0.82
7133	40-46	8.0	28.3	0.1	11.5	20.8	3.0	0.74
7134	46-56	8.1	29.7	1.9	10.8	8.9	3.2	1.01
7135	56-65	7.6	39.0	13.03	17.0	33.3	3.7	0.74
Coal Seam	65-90							
7136	90-100	7.7	36.3	2.23	15.0	8.7	5.3	1.54

8

Table ___ Results of Mechanical Analysis (Hydrometer Method) with Nitrates and Micro Nutrients (Zinc, Iron, Copper, and Manganese) for Overburden Samples. Western Energy Coal Company. Area E-2.

Hole # N47 E65

Lab No.	Depth	% Clay	% Silt	% Sand	Texture	NO_3	Zn	Fe	Cu	Mn
	feet									
7129	0-10	8.0	19.6	72.4	SL	0.25	52.6	4.6	1.6	7.0
7130	10-20	8.0	8.4	83.6	LS	0.25	6.0	4.6	1.1	3.6
7131	20-30	3.8	14.2	82.0	LS	0.25	4.3	6.0	1.1	3.6
7132	30-40	8.4	11.2	80.4	SL	0.25	0.9	2.0	1.2	3.4
7133	40-46	10.0	6.0	84.0	LS	0.25	1.6	6.6	1.4	4.8
7134	46-56	12.0	8.0	80.0	SL	0.25	7.5	15.8	2.0	6.4
7135	56-65	35.2	20.8	44.0	CL	0.25	19.0	19.0	2.3	5.8
Coal Seam	65-90									
7136	90-100	26.0	42.6	31.4	SiL	0.25	4.2	8.0	3.0	4.4

Table ____ Chemical Analysis of Overburden Samples. Western Energy. Area E-2.

Hole # N47 E65

Lab. No.	Depth	Ex. NH_4 (ppm)	Se (ppm)	Hg (ppb)	B (ppm)	Pb (ppm)	Cd (ppm)	Ni (ppm)	Mo (ppm)	CEC meq/100g
7129	0-10	8.0	0.5	20.0	0.3	0.3	0.1	0.3	0.08	4.0
7130	10-20	32.0	0.5	20.0	0.3	1.1	0.1	0.3	0.08	2.6
7131	20-30	11.0	0.5	20.0	0.3	1.3	0.1	0.2	0.06	3.0
7132	30-40	11.0	0.5	10.0	0.3	1.5	0.1	0.3	0.07	2.5
7133	40-46	19.0	0.5	20.0	0.4	1.5	0.1	0.3	0.12	2.0
7134	46-56	15.0	0.5	25.0	0.5	3.6	0.1	0.8	0.13	1.9
7135	56-65	20.0	0.5	5.0	0.6	4.0	0.1	2.4	0.14	27.5
Coal Seam	65-90									
7136	90-100	23.0	0.5	40.0	0.9	6.1	0.1	1.8	2.1	3.8

Hole # N50 F62.5 (Tables 10, 11 & 12)

pH Values above 30 feet were 8.3, 8.5 and 8.4 respectively at 10' increments. These depths may cause fertility imbalance.

Soluble salts at 0-20' were moderately high (4-8 mmhos/cm) and may restrict normal plant growth. This depth should be placed below the surface.

SAR is low on all depths and should not restrict plant root development or permeability.

Textural classes are sandy loam, loamy sand, clay loam and silt loam. [illegible] are [illegible] desirable for permeability and should not restrict plant root development. The loamy sand will have very low water holding capacity. Because leaching of salt is very possible in coarse textured soils, special handling is very important to prevent hard layer to develop at lower depth.

Nitrate nitrogen is very low. Exchangeable ammonium is high and should be a very good source of nitrogen.

DTPA chelatable zinc, manganese, iron and copper were analyzed and shown in Table [illegible]. Concentration of these values were below expected toxicity levels and should not restrict plant growth.

Selenium is below 1.0 ppm and should not restrict plant growth.

Mercury is well below expected toxicity level and should not restrict plant growth. Highest level was 90 ppb HG at 55-62' depth.

Boron is below toxicity level and should not restrict plant growth.

Lead exceeds the level of 5 ppm and may restrict or prevent normal growth. Highest lead levels were found at 35-55' and below the [illegible] coal seam (87-97'). These soils will be evaluated in the green house. Lead levels make it imperative that this depth be given special handling.

Cadmium is all below 0.1 ppm and below expected levels of toxicity.

Nickel toxicity level is 1.0 ppm, and several depths exceed this level. These depths are 56-65', 90-100', 35-62' and below the [illegible] coal seam (87-100'). These levels may restrict plant growth. Green house is recommended.

Molybdenum is all low and will not restrict plant growth.

SUMMARY

1. Soluble salts are moderately high at 0-20' and should be placed below the surface. Conductivity was 4.3 and 7.23 mmhos/cm at 0-10' and 10-20' respectively.

2. Lead exceeds 5 ppm at 35-55' and 87-97'. These depths may restrict normal plant development and should be properly placed well below the surface.

3. Nichel exceeded 1.0 ppm at 35-62' and 87-100'. These levels may restrict normal plant growth.

Table 10 Chemical Properties of Soil and Overburden Materials Associated with Coal Areas. Western Energy Coal Company. Area E-2.

Hole # N50 E62.5

Lab No.	Depth feet	pH Paste	Sat'n. %	Elect. Cond. mmhos/cm.	Saturated Extract Cations Ca meq/liter	Mg meq/liter	Na meq/liter	SAR
7137	0-10	8.3	27.6	4.30	10.8	103.3	7.0	0.99
7138	10-20	8.5	31.5	7.33	23.1	83.8	8.6	1.15
7139	20-30	8.4	28.0	2.53	4.5	24.2	10.0	2.69
7140	30-35	7.7	26.0	2.13	10.4	19.6	4.0	1.04
7141	35-45	7.8	31.5	0.93	6.0	12.9	4.6	1.50
7142	45-55	8.0	26.6	2.20	68.8	10.4	4.0	0.64
7143	55-62	8.1	27.4	2.00	10.8	15.0	3.8	1.07
Coal Seam	62-87							
7144	87-97	8.1	31.5	1.33	11.6	9.3	5.0	1.47
7145	97-100	7.8	26.3	2.00	9.1	8.7	6.3	2.11

Table 11 Results of Mechanical Analysis (Hydrometer Method) with Nitrates and Micro Nutrients (Zinc, Iron, Copper, and Manganese) for Overburden Samples. Western Energy Coal Company. Area E-2.

Hole # N50 E62.5

Lab No.	Depth feet	% Clay	% Silt	% Sand	Texture	NO_3	Zn	Fe	Cu	Mn
7137	0-10	18.0	16.0	66.0	SL	0.25	9.0	3.0	2.3	4.4
7138	10-20	14.8	13.0	72.2	SL	0.25	3.7	3.0	1.4	3.0
7139	20-30	14.4	7.6	78.0	SL	0.25	6.0	3.9	1.0	2.4
7140	30-35	10.8	12.8	76.4	SL	0.25	1.5	6.3	1.0	5.2
7141	35-45	26.2	28.4	45.4	L	0.25	20.6	30.0	2.0	7.4
7142	45-55	22.4	32.0	45.6	L	0.25	5.2	19.2	2.5	5.4
7143	55-62	25.4	23.0	51.6	SCL	0.25	21.4	19.2	2.2	4.4
Coal Seam	62-87									
7144	87-97	28.4	27.6	44.0	L	0.25	14.5	9.2	2.4	4.4
7145	97-100	21.2	13.2	65.5	SCL	0.25	12.2	11.2	1.8	4.2

Table 12 Chemical Analysis of Overburden Samples. Western Energy. Area E-2.

Hole # N50 E62.5

Lab No.	Depth feet	Ex.Mn (ppm)	Se (ppm)	Hg (ppb)	B (ppm)	Pb (ppm)	Cd (ppm)	Ni (ppm)	Mo (ppm)	CEC meq/100gr
7137	0-10	8.0	0.5	5.0	0.6	1.3	0.1	0.2	0.13	6.0
7138	10-20	15.0	0.5	5.0	0.6	1.0	0.1	0.2	0.11	3.8
7139	20-30	7.0	0.5	5.0	0.3	0.9	0.1	0.1	0.13	3.1
7140	30-35	11.0	0.5	5.0	0.2	1.1	0.1	0.2	0.18	3.5
7141	35-45	45.0	0.5	40.0	0.3	5.5	0.1	1.9	0.29	3.7
7142	45-55	31.0	0.5	40.0	0.4	5.3	0.1	1.8	0.40	3.0
7143	55-62	30.0	0.5	90.0	0.6	4.6	0.1	1.8	0.45	8.0
Coal Seam	62-87									
7144	87-97	39.0	0.5	20.0	1.3	7.2	0.1	2.3	0.25	4.3
7145	97-100	29.0	0.5	5.0	1.3	4.7	0.1	1.6	0.80	3.5

Summary

1. Chelatable Zinc was low except at 40-42 feet with 44ppm. This layer may present some problem, but could be mixed with the layor above and below and should present no problem if mixed properly.

2. DPTA chelatable lead exceeded 5ppm between 62-72' and 116-126', and may restrict normal plant growth and development. This layer should be properly placed at lower depth.

3. DPTA chelatable nickel exceed 1;;m between 62-80' and 116-126' and the depth should not be permitted to be left on the surface. Would be preferable it should be mixed with layer inediately abover and below it and placed at lower depth.

4. All other analysis, both physical and sherical should not restrict plant growth and development.

Soluble salts were very low (less than 2.0mmhos/cm) and should not present a problem on seedling establichment, and plant growth and development.

Table 16 Chemical Properties of Soil and Overburden Materials Associated with Coal Areas. Western Energy Coal Company. Area E-2.

Hole # N46 E66.5

Lab No.	Depth	pH Paste	Sat'n.	Elect. Cond.	Saturated Extract			
					Cations			
					Ca	Mg	Na	SAR
	feet		%	mmhos/cm.	- - - - - - - meq/liter - - - - - -			
7157	0-10	8.2	29.8	27.53	30.8	85.4	32.0	4.06
7158	10-20	8.4	29.3	13.83	16.5	41.7	20.5	4.80
7159	20-30	8.3	31.9	13.43	6.0	33.8	13.0	5.28
7160	30-38	8.2	30.0	2.5	7.5	29.2	9.0	2.05
7161	38-44	8.2	30.4	2.03	4.5	21.7	5.9	1.62
7162	44-54	8.0	30.9	1.67	4.0	17.5	4.7	1.43
7163	54-64	8.2	46.2	0.93	5.8	11.2	2.6	0.90
7164	64-74	7.8	41.1	1.03	5.2	9.7	2.2	0.81
7165	74-78	8.0	35.7	1.53	6.5	10.4	1.9	0.67
Coal Seam	78-105							
7166	105-115	7.9	37.9	2.1	8.0	10.4	6.2	2.01
7167	115-118	7.9	54.5	3.43	7.5	8.3	4.8	1.69

Table 17 Results of Mechanical Analysis (Hydrometer Method) with Nitrates and Micro Nutrients (Zinc, Iron, Copper, and Manganese) for Overburden Samples. Western Energy Coal Company. Area E-2.

Hole # N46 E66.5

Lab No.	Depth	% Clay	% Silt	% Sand	Texture	NO_3	Zn	Fe	Cu	Mn
	feet									
7157	0-10	12.0	72.4	15.6	SiL	0.25	1.9	4.0	2.8	3.2
7158	10-20	22.8	24.8	52.4	SCL	0.25	1.5	7.2	2.5	3.2
7159	20-30	22.0	27.4	50.6	SCL	1.85	2.9	6.3	0.9	4.2
7160	30-38	21.6	26.0	52.4	SCL	1.25	3.5	4.4	1.1	4.2
7161	38-44	16.8	26.4	56.8	SL	0.50	13.2	6.3	1.4	3.6
7162	44-54	38.0	39.6	22.4	SiL	0.50	12.2	30.0	2.0	10.4
7163	54-64	47.6	35.6	16.8	SiC	0.50	11.3	65.0	2.0	11.1
7164	64-74	40.0	35.6	24.4	CL	0.50	5.2	30.0	1.8	9.2
7165	74-78	24.4	4.0	71.6	SCL	0.50	3.1	7.8	2.3	4.4
Coal Seam	78-105									
7166	105-115	21.2	25.5	53.3	SL	0.50	3.7	4.4	2.7	8.2
7167	115-118	44.8	24.0	31.2	C	0.50	9.4	22.9	7.2	10.0

Table 18. Chemical Analysis of Overburden Samples. Western Energy. Area E-2.

Hole # N46 E66.5

Lab No.	Depth feet	Ex.NH$_4$ (ppm)	Se (ppm)	Hg (ppb)	B (ppm)	Pb (ppm)	Cd (ppm)	Ni (ppm)	Mo (ppm)	CEC meq/100gr
7157	0-10	10.0	0.5	180.0	0.7	2.2	0.1	0.2	0.15	8.8
7158	10-20	16.0	0.5	40.0	0.6	1.8	0.1	0.1	0.10	4.3
7159	20-30	16.0	0.5	40.0	0.1	1.6	0.1	0.1	0.03	4.4
7160	30-38	16.0	0.5	40.0	0.1	1.5	0.1	0.1	0.03	4.4
7161	38-44	21.0	0.5	50.0	0.1	1.5	0.1	0.1	0.12	3.5
7162	44-54	44.0	0.5	60.0	0.1	6.1	0.1	1.8	0.28	4.4
7163	54-64	40.0	0.5	50.0	0.1	5.4	0.1	1.6	0.25	4.3
7164	64-74	48.0	0.5	50.0	0.3	4.9	0.1	<1.5	0.26	3.8
7165	74-78	24.0	0.5	50.0	0.4	4.6	0.1	2.4	0.46	3.4
Coal Seam	78-105									
7166	105-115	25.0	0.5	40.0	0.6	4.9	0.1	1.2	0.12	2.7
7167	115-118	22.0	0.5	60.0	1.0	5.0	0.1	1.8	0.12	2.7

Hole # N47,850 E58,150 (Tables 19, 20 & 21)

Soluble salts are moderately high on the surface 25 feet, and should not be permitted to be left on the surface. Levels exceed 7.2 mmhos/cm. on the top 25 feet, but less than 2.93 mmhos/cm. from 25 feet and below.

SAR values are below 4.71 and should not present any problems.

Textural class is clay between 45 and 60 feet and should not be permitted to be used for top soil material. Depth beyween 30 and 45 feet appears favorable for top soil material based on soluble salts and textures. If the trace elements appear favorable it can be used for top soil if necessary.

Nitrate Nitrogen is very low, and should not accumulate and threaten underground water supply, runoff into rivers, or collect in stock water ponds.

Exchangeable ammonium varies with depth but are present throughout the hole. The exchangeable ammonium could be a threat to underground or runoff water if not properly used by plants. Because of the nitrogeni present some adjustment on the nitrogen application should be made, especially on the second year.

Selenium is very low and should not restrict plant growth.

Boron is very low and should not restrict plant growth from the toxicity aspect.

Lead is low on the top 40 feet but increases at 40 feet and below. If 5 ppm Pb is considered high, 45-60' and 84-95' should not be permitted for use for top soil material.

Nickel is low on the top 40 feet but exceeds 1.0 ppm at 40 feet and below. If 1.0 ppm is considered high, soil from these depths should not be permitted for use as top soil material.

Molybdenum is very low and should not restrict plant growth.

Hole # N47,850 E58,150 (continued)

Mercury is all very low. The highest value was 24 ppb Hg which should not restrict plant growth.

SUMMARY

1. Top 25 feet of soil exceeds 7.2 mmhos/cm. salt and should not be permitted for use as top soil material.

2. Depth at 40-60' contains clay, lead and nickel that may restrict plant growth and special handling of material should be advised.

3. Zinc appears high; 27, 50 and 11 ppm at 95-100', 100-105' and 105-110' respectively, and should not be permitted for use near surface.

4. Lead exceeded 4.4 ppm at 40-95' excluding the coal layer (60-84').

19

Table 19 Chemical Properties of Soil and Overburden Materials Associated with Coal Areas.
Western Energy Area E-2

Hole # N47,850 E59,150

Lab No.	Depth	Paste	Sat'n.	Elect. Cond.	Saturation Extract Cations Ca	Mg	Na	SAR
	feet		%	mmhos/cm.	- - - - meq/liter - - - - - -			
8184	0-5	8.4	35.9	20.00	5.0	80.3	30.6	4.71
8185	5-10	8.3	31.7	20.17	7.0	75.6	24.5	3.83
8186	10-15	8.3	25.7	20.17	12.1	90.1	30.1	4.18
8187	15-20	8.3	32.6	26.50	4.8	55.1	22.9	2.97
8188	20-25	8.3	28.5	27.23	18.0	59.8	28.3	4.57
8189	25-30	8.3	31.2	2.93	4.7	16.8	9.8	2.98
8190	30-35	8.5	21.9	1.13	2.1	5.7	6.5	3.24
8191	35-40	8.2	26.9	1.00	2.5	5.2	1.6	0.80
8192	40-45	7.8	37.5	2.00	5.5	13.1	3.1	1.03
8193	45-50	7.9	42.7	1.60	6.3	9.2	3.3	1.18
8194	50-55	7.9	42.8	1.30	4.3	6.7	2.9	1.22
8195	55-60	8.0	43.0	1.30	4.3	6.1	3.0	1.30
Coal	60-84							
8196	84-90	7.8	36.6	1.90	6.0	8.4	2.6	0.97
8197	90-95	8.0	35.1	1.40	4.8	7.3	2.7	1.08
8198	95-100	7.9	31.6	1.90	6.0	7.1	3.2	1.22
8199	100-105	7.8	34.7	2.17	8.5	5.5	3.5	1.34
8200	105-110	7.9	33.5	2.17	11.3	10.8	3.1	0.94

Table 20 Results of Mechanical Analysis (Hydrometer Method) with Nitrates and Micro Nutrients (Zinc, Iron, Copper, and Manganese) for Overburden Samples. Western Energy Coal Company. Area E-2.

Hole #N47,850 E59,150

Lab No.	Depth feet	% Clay	% Silt	% Sand	Texture	NO_3	Zn	Fe	Cu	Mn
8184	0-5	10.2	36.4	53.4	SL	0.25	0.8	6.0	1.8	1.4
8185	5-10	1.6	59.4	39.0	SiL	0.25	0.3	4.4	2.4	1.2
8186	10-15	6.0	78.8	15.2	SiL	0.50	0.6	4.6	5.0	1.4
8187	15-20	2.6	35.8	61.6	SL	0.50	0.9	5.8	1.8	1.4
8188	20-25	16.2	26.0	57.8	SL	0.50	6.0	6.6	1.6	5.8
8189	25-30	9.6	8.4	82.0	LS	0.50	1.7	3.8	0.8	1.4
8190	30-35	9.6	14.4	76.0	SL	0.50	0.8	6.0	0.8	5.2
8191	35-40	11.6	15.2	73.2	SL	0.50	4.7	4.0	1.4	16.2
8192	40-45	33.6	26.8	39.6	CL	0.50	6.0	55.0	1.8	15.4
8193	45-50	41.2	32.4	26.4	C	0.50	6.0	30.0	4.8	5.4
8194	50-55	41.2	28.0	30.8	C	0.50	6.0	26.0	3.7	7.6
8195	55-60	44.4	30.0	25.6	C	0.25	6.0	31.0	4.2	5.8
Coal	60-84									
8196	84-90	30.6	30.2	39.2	CL	1.25	6.0	30.0	1.8	5.4
8197	90-95	24.4	53.2	22.4	SiL	0.25	6.0	52.0	3.4	8.9
8198	95-100	22.0	48.4	29.6	L	0.25	24.0	55.0	2.0	8.2
8199	100-105	27.2	41.6	31.2	CL	0.25	50.0	40.0	2.3	9.2
8200	105-110	22.4	53.6	34.0	L	1.85	11.5	42.5	1.4	6.7

Table 21 Chemical Analysis of Overburden Materials Associated with Coal Areas. Western Energy Coal Company, Area E-2

Hole # N47,850 E59,150

Lab No.	Depth Feet	Ex. NH$_4$ (ppm)	Se (ppm)	Hg (ppb)	B (ppm)	Pb (ppm)	Cd (ppm)	Ni (ppm)	Mo (ppm)	CEC meq/100
8184	0-5	10.0	0.5	8.0	0.7	0.7	0.1	0.5	0.26	8.7
8185	5-10	45.0	0.5	8.0	0.8	0.8	0.1	0.5	0.21	11.5
8186	10-20	11.0	0.5	14.0	0.9	1.0	0.1	0.5	0.18	14.0
8187*										
8188	20-30	9.0	0.5	14.0	0.5	0.8	0.1	0.5	0.08	4.0
8189*										
8190	30-35	14.0	0.5	14.0	0.4	0.8	0.1	0.5	0.10	2.5
8191	35-40	14.0	0.5	8.0	0.4	0.8	0.1	0.5	0.10	4.0
8192	40-45	19.0	0.5	8.0	0.6	4.4	0.1	3.0	0.10	9.5
8193	45-50	23.0	0.5	8.0	0.8	5.6	0.1	3.2	0.08	14.0
8194	50-55	15.0	0.5	18.0	0.8	6.6	0.1	1.4	0.04	11.5
8195	55-60	18.0	0.5	24.0	0.9	8.8	0.1	1.2	0.22	12.0
Coal Seam	60-84									
8196	84-90	22.0	0.5	14.0	1.2	7.2	0.1	1.0	0.30	7.0
8197	90-95	40.0	0.5	14.0	1.0	5.4	0.1	2.4	0.62	6.0
8198	95-100	63.0	0.5	8.0	0.9	3.6	0.1	2.0	0.50	5.7
8199	100-110	41.0	0.5	8.0	1.0	2.1	0.1	1.2	0.43	7.5
8200*										

* Depths combined for chemical analysis.

Hole # N49,600 E59,100 (Tables 22, 23 & 24)

Electrical conductivity was 4.2 mmhos/cm at 0-5' and separation of top soil should be made according to horizon information. The remaining depths from this hole are low in salts and should not restrict plant growth if other results show favorable.

Sodium Adsorption Ratio is low and should not restrict plant development by through low water intake, root development or seedling establishment.

Textures are favorable for water intake and plant growth. Textures consist mainly of loamy sand, sandy loam, occassional silt loam, and sandy clay loam.

Nitrate nitrogen is considered very low except at 10-30', 40-45' and 65-70' where levels of 5.5 to 19.5 ppm of nitrate nitrogen were found. These levels are high enough to support plant growth for at least one year. They could be a potential nitrate hazard in water if not properly used by crops or placed near the surface during mining. These depths should not be placed immediately above a clay layer which may restrict water movement downward.

The Exchangeable ammonium was depleted in some depths and it may be possible that it was converted to nitrate after drilling was completed if sample was left exposed to air for a period before analysis was completed. It could be possible also that nitrates could be leached and accummulated at these depths. This is very possible especially if the terrain where the samples were taken was concave and collected run off moisture. The location of some of these nitrates however are not consistent throughout the hole which makes leaching and accummulation questionable. For example, the nitrates are high at both 40-45' and 65-70' depths and very low immediately above or below the depth. This could be due to analytical error, sampling contamination or nitrification of exchangeable ammonium during storage of samples. At any rate these soils should be used appropriately.

Zinc (DTPA chelatable) was exceptionally high at 80-82' and 120-125' with 200 and 600 ppm Zn. These depths happen to be immediately above the Rosebud and McKay coal seams and should not be placed near the surface. Other depths containing zinc near 30 ppm were 60-70' and 75-80'.

Iron was low at all depths except for 65-70' depth with 148 ppm iron. Agriculturally productive soil in Montana contains as high as 50 ppm on the surface 6 inches and sometimes higher without sacrificing plant growth. Levels of toxicity of iron are not definitely defined.

Copper and manganese are low and should not restrict plant growth.

Selenium is less than 0.5 ppm and should not restrict plant growth.

Mercury is less than 32 ppm and should not restrict plant growth.

Boron is less than 1.3 ppm and well below anticipated level of problems.

Lead levels at 50-82' exceeded 2 ppm and may offer some resistance to plant growth.

Cadmium is all less than 0.1 ppm except 120-125' with 0.2 ppm. Although this level is considered potentially hazardous, mixing this depth with the above soil should prevent any level high enough to restrict plant growth.

(Holo # 49,600 E59,100, continued)

Nickel is less than 2 ppm and should not restrict plant growth.

Molybdenum is below 1 ppm and should not restrict plant growth.

SUMMARY

1. Soluble salts were present only on the top five feet and information obtained from horizon analysis should be used to determine top soil potential.

2. Nitrate accummulation found at 10-30', 40-45', and 65-70'. Nitrate accummulation of 5.5 to 19.5 ppm were found. These levels can support plant growth for a year and if placed near rooting zone, nitrogen requirement should be adjusted.

3. Exchangeable ammonium is lower than normally found and nitrification of samples during storage is anticipated.

4. Zinc was exceptionally high at 80-82' and 120-125' with 200 and 600 ppm Zn. These levels occur immediately above the Rosebud and McKay coal seams and should not be permitted to be placed near the surface.

5. Lead levels exceeded 2 ppm at 50-82' and may offer some resistance to normal plant growth.

Table 22 Chemical Properties of Soil and Overburden Materials Associated with Coal Areas.
Western Energy Area 8 Hole # N49,600 E59,100

Lab No.	Depth	pH Paste	Sat'n.	Elect. Cond.	Saturation Extract			
					Cations			
					Ca	Mg	Na	SAR
	feet		%	mmhos/cm	- - - - - - meq/liter - - - - - -			
8201	0-5	8.3	33.5	4.20	1.3	2.4	0.4	0.30
8202	5-10	8.3	30.8	1.07	5.2	3.8	2.3	1.00
8203	10-15	8.2	30.1	0.80	3.0	3.1	1.4	0.77
8204	15-20	8.2	31.9	0.80	2.3	3.7	0.6	0.36
8205	20-25	8.0	28.6	0.90	5.0	2.9	0.2	0.09
8206	25-30	8.4	27.7	0.40	0.5	2.3	0.3	0.25
8207	30-35	8.6	32.3	0.23	0.1	1.6	0.5	0.43
8208	35-40	8.7	30.8	0.23	0.1	2.0	0.8	0.73
8209	40-45	8.7	28.5	0.37	0.1	1.8	0.7	0.70
8210	45-50	8.5	29.3	0.50	0.8	2.6	0.7	0.54
8211	50-55	8.2	32.0	1.10	4.1	5.5	1.0	0.21
8212	55-60	8.2	33.5	0.90	4.5	4.4	1.0	0.43
8213	60-65	8.2	30.9	0.90	2.1	4.1	1.4	0.77
8214	65-70	8.1	33.6	0.93	2.3	3.9	1.7	0.94
8215	70-75	8.2	25.2	1.00	2.1	3.6	2.5	1.48
8216	75-80	7.8	27.4	1.90	10.1	9.1	3.7	1.19
8217	80-82	7.9	26.6	1.60	7.1	7.6	3.4	1.26
8218	105-110	7.9	25.0	1.80	7.8	6.6	6.6	2.46
8219	110-115	8.3	27.4	1.30	3.1	2.8	6.3	2.33
8220	115-120	8.1	28.7	1.10	4.3	3.5	6.7	3.55
8221	120-125	8.2	23.7	1.20	2.8	2.9	4.8	2.62

82-78'

Coal 82-105'

Table 23 Results of Mechanical Analysis (Hydrometer Method) with Nitrates and Micro Nutrients (Zinc, Iron, Copper, and Manganese) for Overburden Samples. Western Energy Coal Company. Area E-2.

Hole # N49,600 E59,100

Lab No.	Depth feet	% Clay	% Silt	% Sand	Texture	NO_3	Zn	Fe	Cu	Mn
8201	0-5	7.6	12.8	79.6	LS	0.25		3.2	1.6	2.0
8202	5-10	11.6	10.8	77.6	SL	0.25	1.7	3.9	1.1	1.8
8203	10-15	5.4	8.8	85.8	LS	5.50	0.01	3.2	0.9	1.8
8204	15-20	5.8	15.8	78.4	LS	7.50	1.2	2.6	0.9	2.0
8205	20-25	10.6	10.4	79.0	SL	19.50	6.0	3.0	1.0	3.2
8206	25-30	16.4	15.0	68.6	SL	5.00	4.1	2.0	1.5	1.8
8207	30-35	6.8	8.2	85.0	LS	0.25	2.0	2.8	0.6	1.2
8208	35-40	11.6	6.2	82.2	SL	0.25	13.0	3.9	0.8	2.4
8209	40-45	7.6	8.8	83.6	LS	11.00	6.8	4.0	1.2	2.0
8210	45-50	11.0	10.8	78.2	SL	0.25	5.0	2.2	1.1	2.8
8211	50-55	10.6	14.4	75.0	SL	0.25	3.2	15.8	2.9	6.2
8212	55-60	16.0	12.8	71.2	SL	0.25	3.3	29.2	3.4	9.5
8213	60-65	12.6	18.8	68.6	SL	0.25	33.8	26.8	3.6	9.2
8214	65-70	16.6	10.8	72.6	SL	19.50	28.6	148.0	4.5	11.1
8215	70-75	14.8	57.2	28.0	SiL	0.25	3.8	5.2	3.6	6.7
8216	75-80	27.2	52.8	20.0	CL	0.25	29.2	19.9	4.6	7.4
8217	80-82	25.6	23.2	51.2	SCL	0.25	200.0	2.6	4.8	11.1
Coal	82-105									
8218	105-110	23.2	13.6	63.2	SCL	0.25	2.1	16.6	2.0	6.4
8219	110-115	11.6	19.8	68.6	SL	0.25	13.0	26.8	6.0	6.7
8220	115-120	12.6	22.2	65.2	SL	0.25	4.4	38.0	2.8	5.2
8221	120-125	11.2	21.8	67.0	SL	0.25	600.0	30.0	1.6	11.1

B2-79

Table 24 Chemical Analysis of Overburden Materials Associated with Coal Areas. Western Energy Coal Company, Area E-2

Hole # N49,600 E59,100

Lab No.	Depth feet	Ex.NH (ppm)	Se (ppm)	Hg (ppb)	B (ppm)	Pb (ppm)	Cd (ppm)	Ni (ppm)	Mo (ppm)	CEC meq/100gr
8201	0-5	6.0	0.5	18.0	0.2	0.7	0.1	0.5	0.04	18.3
8202	5-10	7.0	0.5	18.0	0.3	0.6	0.1	0.5	0.03	5.5
8203	10-20	8.0	0.5	32.0	0.2	0.6	0.1	0.5	0.07	4.8
8204*										
8205	20-30	10.0	0.5	18.0	0.3	0.6	0.1	0.5	0.06	6.3
8206*										
8207	30-40	11.0	0.5	14.0	0.3	0.5	0.1	0.5	0.04	5.0
8208*										
8209	40-45	6.0	0.5	18.0	0.2	0.7	0.1	0.5	0.03	4.0
8210	45-50	7.0	0.5	14.0	0.3	0.9	0.1	0.5	0.03	3.5
8211	50-60	23.0	0.5	8.0	0.3	2.0	0.1	1.4	0.06	5.0
8212*										
8213	60-65	33.0	0.5	6.0	0.3	3.2	0.1	1.6	0.09	5.0
8214	65-70	28.0	0.5	14.0	0.3	3.2	0.1	1.8	0.11	4.7
8215	70-75	21.0	0.5	14.0	0.4	1.9	0.1	1.2	0.11	3.0
8216	75-82	24.0	0.5	20.0	0.6	3.0	0.1	2.0	0.02	5.0
8217*										3.5
Coal Seam	82-105									
8218	105-110	18.0	0.5	6.0	1.1	1.5	0.1	0.8	0.02	3.5
8219	110-120	18.0	0.5	14.0	0.9	1.3	0.1	0.8	0.05	2.5
8220*										
8221	120-125	23.0	0.5	6.0	1.3	0.3	0.2	0.6	0.04	3.5

* Depths combined for chemical analysis

Hole # N51,300 E60,200 (Tables 25, 26, & 27)

Soluble salts are very low and anticipate all crops and grasses to perform well.

Sodium Adsorption Ratio are also very low and expect very little crusting from dispersion of soils.

Textures are considered favorable for all except at 165-169' where heavy clay texture was present. It occurs below the second coal seam and should not be permitted for use near the surface.

Nitrate nitrogen is considered very low on all depths and should not be potentially hazardous for underground water or surface run off into streams.

Exchangeable ammonium is present on all depths and nitrogen application or requirement for grass extablishment should be adjusted.

Selenium, mercury, boron, cadmium, molybdenum are all below expected level to restrict plant growth and should not present any problem.

Lead exceeded 5 ppm at 70-75', but if it is mixed with soil above and below this depth, it should not restrict plant growth.

EDPA chelatable Nickel exceeded 100 ppm at 10-30' and 65-132'. The only oth depth that exceeded 5 ppm was at 111-115' immediately above the first coal seam. These depths should not be permitted to be used near the surface. Values above 1.0 ppm should be used with caution until better understanding of the relative values are obtained.

SUMMARY

1. Soil contains very low soluble salts which should not restrict plant growth.

2. Exchangeable ammonium is present and can be potentially hazardous to underground water or stream run off oa nitrate if not properly placed and used by plants.

3. Clay texture at 164-169' should not be permitted to be placed near the surface. This layer was found immediately below the second coal seam.

4. Lead exceeded 5 ppm at 70-75' but if it is mixed with soil above and below this layer, it should dilute the concentration and not restrict plant growth.

5. Nickel exceeded 5 ppm at 111-115' , above the first coal seam. This layer should not be permitted for use near the surface.

Table 8: Chemical Properties of Soil and Overburden Materials Associated with Coal Areas.
Western Energy Area B Hole # N51,300 E60,200

Lab No.	Depth	pH Paste	Sat'n.	Elect. Cond.	Saturation Extract Cations Ca	Mg	Na	SAR
	feet		%	mmhos.cm	- - - - - - meq/liter	- - - - - -		
8222	0-5	8.3	30.0	0.32	1.6	0.9	0.7	0.63
8223	5-10	8.4	24.0	0.50	1.5	2.7	1.7	1.13
8224	10-15	8.4	31.1	0.20	1.0	2.4	1.4	1.07
8225	15-20	8.6	33.5	0.30	0.1	1.4	1.1	1.22
8226	20-25	8.6	27.4	0.20	0.6	0.7	0.9	1.14
8227	25-30	8.7	32.1	0.75	0.1	0.9	0.8	1.12
8228	30-35	8.6	30.9	1.50	0.1	1.4	0.8	1.00
8229	35-40	8.7	30.2	1.75	0.1	1.1	0.7	0.86
8230	40-45	8.2	32.0	1.00	1.6	2.6	0.8	0.53
8231	45-50	8.4	33.9	0.20	1.9	2.8	0.8	0.53
8232	50-55	8.5	28.5	0.50	0.6	1.2	0.7	0.72
8233	55-60	8.5	21.1	0.40	0.5	0.9	0.6	0.71
8234	60-65	8.5	32.1	0.30	1.0	1.6	0.6	0.44
8235	65-70	8.3	32.0	1.40	3.1	3.0	0.8	0.46
8236	70-75	8.4	30.3	1.00	2.1	2.4	1.2	0.78
8237	75-80	8.3	27.0	1.00	3.0	3.1	1.4	0.77
8238	80-85	8.2	28.7	1.50	6.0	5.5	1.6	0.57
Coal	85-111							
8239	111-115	7.5	34.7	1.90	11.1	8.1	1.7	0.55
8240	115-120	8.0	31.4	1.20	3.1	8.6	1.5	0.62
8241	120-125	7.8	32.2	1.40	5.4	4.8	1.9	0.83
8242	125-130	8.0	35.3	1.40	5.0	5.3	2.0	0.87
8243	130-132	8.2	30.6	1.20	3.9	3.5	2.4	1.26
8244	164-169	7.4	50.8	2.20	9.1	8.3	4.4	1.48
8245	169-174	7.5	29.4	3.75	28.8	18.3	6.3	1.29

83-82

Table 26 Results of Mechanical Analysis (Hydrometer Method) with Nitrates and Micro Nutrients (Zinc, Iron, Copper, and Manganese) for Overburden Samples. Western Energy Coal Company. Area E-2

Hole # N51,300 E60,200

Lab No.	Depth	% Clay	% Silt	% Sand	Texture	NO_3	Zn	Fe	Cu	Mn
8222	0-5	11.6	10.6	77.8	SL	0.25	10.5	4.9	0.6	2.4
8223	5-10	23.2	21.6	55.2	SCL	0.25	132.5	66.0	1.8	24.0
8224	10-15	31.2	28.8	40.0	CL	0.25	3.4	30.0	1.0	7.4
8225	15-20	5.6	17.2	77.2	LS	0.25	0.7	13.3	2.4	4.2
8226	20-25	11.2	11.0	77.8	SL	0.25	3.5	12.8	1.0	3.4
8227	25-30	7.8	6.6	85.6	LS	0.25	0.9	10.0	0.8	2.8
8228	30-35	9.2	8.0	82.5	LS	0.25	1.0	11.5	0.9	3.2
8229	35-40	6.6	8.0	85.4	LS	0.25	0.4	13.5	0.6	3.4
8230	40-45	32.0	43.6	24.4	CL	0.25	20.0	112.0	3.2	16.5
8231	45-50	32.0	38.8	29.9	CL	0.25	5.2	115.0	2.5	10.2
8232	50-55	10.0	8.8	81.2	LS	0.25	0.2	24.0	0.4	5.4
8233	55-60	4.2	15.0	80.8	LS	0.25	1.2	19.2	0.8	4.8
8234	60-65	6.0	11.4	82.6	LS	0.25	1.1	12.8	0.6	3.6
8235	65-70	6.8	10.6	82.6	LS	0.25	2.2	38.0	0.8	3.2
8236	70-75	9.2	13.0	77.2	SL	0.25	5.3	40.0	0.6	2.8
8237	75-80	8.0	14.0	74.0	LS	0.25	11.5	38.0	1.1	3.4
8238	80-85	12.0	15.2	72.8	SL	0.25	28.0	32.0	2.6	3.2
Coal	85-111									
8239	111-115	20.2	41.6	38.2	L	0.25	11.5	60.0	2.2	10.0
8240	115-120	16.4	45.9	37.8	L	0.25	2.1	55.0	4.0	9.5
8241	120-125	13.2	50.8	36.0	SiL	0.25	92.5	90.0	3.0	13.1
8242	125-130	22.8	42.8	34.4	L	0.25	1.9	70.0	4.0	11.1
8243	130-132	15.2	17.6	67.2	SL	0.25	1.1	55.0	4.8	8.2
Coal	132-164									
8244	164-169	47.6	28.6	23.6	C	0.25	11.2	55.0	3.8	7.4
8245	169-174	31.0	20.6	48.4	SCL	0.25	1.2	40.0	4.0	8.0

B2-83

Table 27 Chemical Analysis of Overburden Materials Associated with Coal Areas. Western Energy Coal Company, Area E-2

Hole #N51,300 E60,200

Lab No.	Depth feet	Ex.NH (ppm)	Se (ppm)	Hg (ppb)	B (ppm)	Pb (ppm)	Cd (ppm)	Ni (ppm)	Mo (ppm)	CEC meq/100gr.
8222	0-5	49.0	0.5	14.0	0.5	0.6	0.1	0.5	0.08	5.0
8223	5-10	24.0	0.5	14.0	0.8	0.6	0.1	0.5	0.06	6.0
8224	10-15	22.0	0.5	28.0	0.7	0.7	0.1	1.6	0.11	6.5
8225	15-20	10.0	0.5	58.0	0.8	0.6	0.1	1.8	0.11	4.5
8226	20-25	10.0	0.5	162.0	0.7	0.6	0.1	1.4	0.11	4.3
8227	25-30	10.0	0.5	86.0	0.4	0.6	0.1	2.0	0.14	3.7
8228	30-40	14.0	0.5	64.0	0.5	0.6	0.1	0.8	0.40	4.0
8229*										
8230	40-50	34.0	0.5	20.0	0.5	2.4	0.1	0.8	0.19	10.5
8231*				20.0						
8232	50-60	12.0	0.5	20.0	0.4	0.7	0.1	0.6	0.06	3.3
8233*										
8234	60-65	17.0	0.5	14.0	0.4	0.7	0.1	0.5	0.07	2.5
8235	65-70	14.0	0.5	14.0	0.4	1.0	0.1	1.8	0.04	1.6
8236	70-75	16.0	0.5	20.0	0.4	9.0	0.1	1.6	0.04	2.0
8237	75-85	18.0	0.5	20.0	0.3	1.2	0.1	1.2	0.03	1.8
8238*										
Coal Seam 85-111										
8239	111-115	31.0	0.5	6.0	2.0	4.4	0.1	7.0	0.04	5.8
8240	115-120	44.0	0.5	6.0	0.6	3.2	0.1	1.8	0.05	3.5
8241	120-125	44.0	0.5	6.0	1.2	2.0	0.1	1.4	0.11	4.5
8242	125-130	40.0	0.5	6.0	0.8	3.0	0.1	1.4	0.15	4.2
8243	130-132	43.0	0.5	14.0	0.7	2.0	0.1	1.6	0.15	3.2

* Depths combined for chemical analysis

APPENDIX (1)

1. pH is a measure of hydrogen ion activity. Productive soils have a pH in the range 6.0 to 8.0. For Great Plains soils, pH less than 6 is uncommon while values higher than 8.2 may indicate a problem, e.g. undesirable soluble carbonate content, low solubility of calcium salts, nutritional imbalance, etc. Determinations were made on water-saturated materials.
2. $CaCO_3$ (equivalent) evaluates alkaline earth carbonate concentration expressed as $CaCO_3$. Included are calcite, dolomite, and possible magnesite. Alkaline earth carbonates are important as a potential source of calcium and magnesium for replacement of adsorbed sodium (exchangeable sodium) on the cation exchange complex of clay minerals.
3. Particle size analysis diagnoses the textural properties, i.e. sandy loam, clay loam, clay, etc. When clay content (particles $<$ 0.002mm) is greater than 40%, the material is classed as clay and generally has associated agronomic problems of poor tilth and restricted infiltration.
4. Saturation or the amount of water required to saturate the material, expressed as percentage by weight, is influenced by particle size (texture), organic matter content, chemical, and mineralogical composition. Extremely high values may indicate high clay content of montmorillonitic mineralogy, with high quantities of exchangeable sodium.
5. Electrical conductivity (EC) is directly related to the concentration of electrolytes in solution. The EC, expressed as millimhos per cm as 25c, of saturation extracts is used for appraising the effect of salinity on plant growth. EC less than 2 has negligible effect, 2 to

4 is considered slightly saline, 4 to 8 is moderate, 8 to 16 is severe because only tolerant plants will grow satisfactorily, and values over 16 indicate very severe salinity.

Electrical conductivity of the soil solution or extract is a function of the salt content of the soil and related to plant growth potential of each soil. The conductivity of these extracts are grouped for crops that are restricted to under 4 mmhos/cm or those that can exceed 8 mmhos/cm. Soil containing greater than 4 mmhos/cm is considered "moderately saline" and will decrease plant growth and production. It is believed that salts generally affect plant growth either by (1) decreasing the availability of water to plants by increasing solute suction and causing the plant to require more energy to absorb and translocate water; (2) salts act within the plant by lowering the free energy of internal water and preventing physiological processes that require water; and (3) some ions are directly toxic to plants.

6. Cationic concentration (Na, Ca, Mg) of water extracts at saturation gives information on the composition of soluble salts and of exchangeable or adsorbed cations in the material.

7. Sodium Adsorption Ratio (SAR) is an empirical relationship to express the relative activity of sodium ions in exchange reactions with soil when the soil is at equilibrium with its solution. The SAR is calculated by the formula:

$$SAR = Na/\sqrt{(Ca+Mg)/2}$$

Ionic concentrations are expressed in milliequivalents per liter (meq/l) of solution. Because SAR is usually highly correlated with exchangeable sodium percentage, values greater than about 10-12 indicate potential problems in structural stability and permeability. Soils that have excessive concentrations of sodium are called "alkali". When sodium becomes the dominant cation in the soil solution or the exchange complexxes of soil, it will exceed 15% of the exchangeable cation. The relative proportion of sodium increases as the calcium and magnesium activity decreases by precipitation when soil solution becomes more concentrated. As the calcium and magnesium activity decrease, the sodium cation will become more dominant (greater than 50%) and replace calcium and magnesium cation on the exchange complex by "mass action". Therefore SAR is a measurement of this ratio and is used to locate and predict those problems that can be injurious for plant development. Soils having SAR greater than 10 are expected to have some problems and reclamation by correcting drainage and addition of gypsum or other amendments will be required. High sodium values will disperse the fine particles and cause crusting of soils and other poor physical properties associated with it.

(1) Lignite Mine Spoils in the Northern Great Plains- Characteristics and Potential for Reclamation by F.M. Sandoval, J.J.Bond, J.F.Power & W.O. Willis, Northern Great Plains Research Center; Agricultural Research Service, USDA, Mandan, N. Dakota.

OVERBURDEN ANALYSES AND DISCUSSION
OF DRILL HOLE NOS. N43E69 and N51E61
MINE AREA

from

WESTERN ENERGY COMPANY'S
1973
MONTANA STRIP MINING PERMIT APPLICATION

OVERBURDEN AND INTERBURDEN ANALYSIS AS RELATED TO REVEGETATION

Justification:

Undesirable soil characteristics such as high sodium (SAR), high salt, high percentage of clay, structures that cause very little water intake, and low fertility may inhibit reclamation. This soil analysis and the plant growth study were conducted to evaluate the potential reclamation problems that may occur from overburden and interburden materials.

Methods and Materials:

Two sets of samples were collected for each mining area by the Western Energy Company. Samples were taken at 12" increments until the coal was contacted. The samples were composited by depth according to the layers and related to the log that was provided by the Western Energy Company. Not more than 10 feet intervals were composited when the layer was almost the same throughout the interval. Occasionally, when the soil was sandy, samples from more than 10 feet were compiled. One set of samples, Area Pit #6 A10, was taken at 10 foot increments. Analysis and report were made accordingly.

Sample Preparation:

Samples were air dried and divided into two by taking alternate 6 inches of soil from each 12" tube. One half was kept in the plastic tube for future use and the other half was prepared for the complete soil analysis.

When necessary, samples were crushed to 1" by a jaw crusher, mixed and then divided into the following portions:

1. 500 grams for weathering and screen analysis wherever desired.
2. 500 grams screened (<9 mesh) for mechanical analysis.
3. Screen <12 mesh and divide into two - one half for greenhouse study and the other half for laboratory analysis.
4. Samples for laboratory analysis were screened to 20 mesh size. Samples designated for greenhouse could also be used for the weathering tests wherever desired.

5. 100 grams were sent to the U. S. Testing Lab for trace elements analysis.

6. For mechanical analysis, samples were screened to size 9 mesh.

Chemical Analysis

1. pH and conductivity - soil to solution of ratio 1:2.

2. Sodium Adsorption Ratio - (qualified by sodium content).

3. Sodium Exchange Potential - (calculate if necessary - CEC also). This has the same interpretation value as SAR.

4. Macro Analysis - organic matter, nitrate, phosphorous, potassium, calcium, magnesium, sodium, sulfur.

5. Micro Analysis - copper, iron, manganese, zinc, aluminum, barium, cadmium, lead, mercury, silicon, strontium, titanium, selenium, fluoride, molybdenum, arsenic, boron.

6. Soluble Salts.

7. CEC.

8. Mechanical Analysis.

9. Water Holding Capacity, at 0.33 bar and 15 bar suction (method developed by Gordon Decker "Automatic Retrieval and Analysis of Soil Characterization Data" PhD Thesis Montana State University, Bozeman, Montana, December 1972).

10. Plant Growth Tests.

a) 500 grams of air dry soil (or less if 500 grams of soil were not available).

b) Add 50 ppm P as concentrated super phosphate.

c) Add 50 ppm N as NH_4NO_3 on weekly basis.

d) Seeded to Winoda winter wheat 6 seeds/pot.

e) Water with distilled water to 0.33 bar or field capacity and weight maintained on daily basis.

f) Harvest - Report dry weight, tillers, and stand.

RESULTS AND DISCUSSION AREA A1:

Hole #N52E50 Lab No. 1595-1604 - A1-1
Hole #N51E53 Lab No. 1630-1637 - A1-2

RESULTS AND DISCUSSION AREA E

Hole #N43-E69 Lab No. 1605-1614

Hole #N51-E61 Lab No. 1638-1651

Western Energy Company Test Hole Data: **Drill Hole No. N43 E69**

Prospect: Area E

Date: 9-12-73

Depth, feet	Formation Record	Sample Depth, ft.	Montana Testing Lab No.
0-69			
0-46	Light brown, fine grained sandstone	0-10	1605
		10-20	1606
		20-30	1607
		30-43	1608
		43-46	1609
46-69	Gray sandstone & shale	46-56	1610
		56-60	1611
		60-65	1612
		65-68	1613
		68-69	1614

Western Energy Company Test Hole Data: **Drill Hole No. N51 #61**

Prospect: Area E

Date: 9-13-73

Depth, feet	Formation Record	Sample Depth, ft.	Montana Testing Lab No.
0-36	Light brown fine grained	0-10	1638
		11-20	1639
		21-30	1640
		31-36	1641
36-38	Gray shale & sandstone	37-38	1642
38-47	Light brown fine grained	38-47	1643
47-53	Gray shale & sandstone	47-53	1644
53-56	Light brown fine grained sandstone	53-56	1645
		56-70	1656
56-91	Gray sandstone & shale	71-80	1647
		81-85	1648
		85-87	1649
		88-89	1650
		90-91	1650

Chemical and Physical Analyses

1. pH values in both holes are high and suggest the presence of sodium and/or toxic trace elements such as aluminum. (pH is used to predict excess iron or aluminum that may interfere with the availability of phosphorous and high sodium concentrations that may affect the water intake of the soil).

2. Sodium Adsorption Ratio (SAR) - Because pH values were high, SAR values were suspected to be high as well. However, ammonium acetate sodium concentrations were less than 0.3 me/100 gm of soil and SAR values were less than 2.0. No problem associated with sodium dispersion of soil particles causing low hydraulic conductivity and low water intake are anticipated.

3. Sodium Exchange Potential - Not applicable to these soils because the SAR values were very low.

4. Macro Analysis - Organic Matter was very low on all samples. Organic matter increases as it approaches the coal seam due to reasons given previously.

Nitrate-Nitrogen is very low at all depths.

Supplemental Nitrogen will be required.

Phosphorous, Potassium, Calcium, Magnessium, and Sulfur - Sodium bicarbonate extractable phosphorous is less than 1.0 ppm on all depths. This soil is very deficient in phosphorous and may require one or two annual applications for two years.

The available potassium is considered low in both holes in Area E. After mixing, it is very important that potassium become part of the fertilizer requirement in establishment of permanent cover.

Calcium and magnesium levels are well within the range found in Montana soils. No layer or depth indicate unusual concentration and should not present any growth establishment problem.

Sulfur is very high throughout the lower depth. If the lower depth (10') is to be mixed with the surface soil, additional sulfur may not be required. In this area it is suggested that only the upper 5 feet of top soil be stockpiled.

5. Micro Analysis - EDTA extractable - The micro nutrient extractable DTPA do not show deficiencies in any depth in both holes of Area E. The iron concentration increases in the layer where clay content is higher. The levels found in this layer will not cause any toxicity to plant growth but this layer should be separated from others as carefully as possible. The layer above this dense clay layer should be separated with caution.

No unusual amounts of other trace elements were found in these soils that would cause deficiency or toxicity to plant growth.

6. Soluble Salts - Soluble salts were low (less than 2 mmhos/cm) at all depths from the two holes taken in Area E. Very little salt problems are anticipated but if soil appears white, it is probably related to high sulfur sulfate in the profile.

7. CEC - Cation Exchange Capacity is not applicable to these soils.

8. Mechanical Analysis - Holes #N43E69 and #N51E61 contain a layer high in clay. It contains a clay loam layer at a depth of 43 to 46 feet. It is not a very dense clay layer but may restrict water intake. Hole #N51E61 contains a high percent clay layer that should not be permitted to be within the top 8' of soil. This layer is located at a depth of 48-53 feet. It is desirable that this clay layer be mixed with some coarse textured soil and be placed below 8 feet from the surface. Percent of clay could be reduced by intermixing layers that will cause changes in texture and composition.

The layer above the coal seam did not exhibit a high percent of clay (26.8%) and sodium and salt concentrations were very low.

9. Water Holding Capacity - The suction between 0.33 and 15 bars represents the amount of water held by the soil and available to the plant. The loamy sands and sandy loams will have low holding capacities while the clay loams and clays will exhibit very high water holding capacities.

10. Plant Growth Test - In progress. No plant growth problems associated with salt, sodium, or low hydraulic conductivity are anticipated from the layer that contains high clay content.

Report will be submitted separately when completed.

RECOMMENDATION:

1. The clay layer found in Hole #N51E61 should not be permitted to be placed near the surface. It is desirable to mix it with sandy soil and place it at lower depths.

2. Trace elements seem to increase as clay content increases. Careful sampling of all dense layers above it is recommended. It should be emphasized that two samples tested, Lab No. 1644 and 1651, Table 2, showed high levels of boron (6.3 ppm and 23.0 ppm, respectively). This should be checked for, and if levels >4.0 ppm are found in other locations during reclamation, those portions should not be replaced near the bed of the restored Rosebud aquifer (to prevent the chance of future leaching out) nor closer than 8 feet of the surface.

3. The parting layer did not have high levels of SAR or salt. Percent clay seems to be higher but will not lower hydraulic conductivity and water intake from the level found.

4. See stockpiling recommendations that accompany the soil descriptions.

Date Rec'd ...-75
Date Sent

RESULTS
DEEP SOIL SAMPLE ANALYSIS

FROM:
Montana Testing L
P. O. Box
Great Falls, Montana

FROM: ... Energy Co.
(Grower)

Area B Overburden N 43 E 69

CLIENT:
(Dealer)

B2-95

Lab No.	Field No.	Depth Inches	pH	Carbonate	Nitrate Nitrogen ppm	Lbs./Ac. N	Phosphorus P ppm	Potassium K ppm	Calcium Ca meq/100g	Magnesium Mg meq/100g	Sodium Na meq/100g	Salt Hazard mmhos	Soil Texture	[illegible]
1605		0-10	8.6	0.1	0.5		0.03	83	28.9	3.8	0.1	0.4	LFS	H+
1606		10-20	9.0	0.1	0.5		0.03	113	30.7	4.6	0.1	0.4	FSL	V-
1607		20-30	8.9	0.1	0.25		0.03	113	21.1	3.0	0.1	0.3	LFS	H
1608		30-45	8.9	0.1	0.5		0.03	113	21.5	3.0	0.1	0.3	SL-	M+
1609		45-46	8.7	0.1	0.25		0.03	83	+35	4.8	0.1	0.5	L	M+
1610		[illegible]	8.8	0.3	0.25		0.03	113	20.9	3.4	0.1	0.4	L+	V
1611		50-60	8.7	1.3	0.25		0.03	83	24.5	3.4	0.1	0.6	L+	M+
1612		60-65	9.0	0.1	0.25		0.03	113	13.0	2.5	0.1	0.5	VFSL	M-
1613		65-68	8.8	0.1	0.25		0.08	113	3.3	2.7	0.3	0.6	FSL	0
1614		68-69	8.7	0.6	0.25		0.03	86	1.6	3.2	0.1	0.6	SL	0

OTHER TESTS REQUIRED

Sulfur ppm	Zinc ppm	Iron ppm	Copper ppm	Manganese ppm	Boron ppm	0.3 ATM	15 ATM	[illegible]	Cation Exchange Capacity (CEC)	Mechanical Analysis % Clay	% Silt	% Sand	Others
								SAR					
10.2	6.0	4.9	1.8	2.8		7.8	3.9	1.28		12.8	2.4	84.8	LS
7.4	20.6	21.2	1.0	8.6		9.0	4.5	0.92		14.8	8.4	76.8	SL
4.1	5.2	5.8	1.2	2.8		7.8	3.9	0.72		12.8	2.4	84.8	LS
7.0	0.8	10.2	1.4	8.0		6.8	3.4	0.85		10.8	0.4	88.8	LS
10.2	27.5	61.3	2.2	11.7		18.4	9.2	0.84		30.8	30.4	38.8	CL
11.0	19.4	47.5	2.3	5.8		14.84	7.42	0.84		24.8	16.4	58.8	SCL
70.7	2.6	21.5	2.3	4.4		16.2	8.1	0.59		26.8	34.4	38.8	L
31.4	9.4	12.0	1.0	1.8		7.8	3.9	0.80		12.8	14.4	72.8	SL
65.3	6.0	14.0	1.4	2.0		7.0	3.9	0.50		12.8	10.4	76.8	SL
55.0	3.7	23.0	3.2	2.4		9.1	4.55	0.53		14.8	0.4	84.8	LS

WESTERN ENERGY AREA E OVERBURDEN, MICRONUTRIENTS

5e

N43 E69

Lab No.	Depth	Ba	As	B	Ti	Mo	Sr	SiO2	F	Water soluble F	Hg	Pb	Cd	Al
605	0-10	7.5	2.0	0.5	< 1	0.11	7.0	68.51	432	0.68	8.0	0.4	< .5	< 1
1606	10-20	20.0	1.0	0.5	< 1	0.14	8.5	56.64	432	0.44	13.0	0.4	0.5	< 1
1607	20-30	21.0	1.0	0.3	< 1	0.09	9.0	72.18	428	0.12	10.8	0.4	0.5	< 1
1608	30-43	7.5	2.0	0.3	< 1	0.12	9.0	57.71	408	0.24	19.0	0.3	0.5	< 1
1609	43-46	12.5	4.0	0.4	< 1	0.2	10.5	56.67	544	0.02	28.0	1.6	0.5	< 1
1610	46-56	7.0	1.0	0.6	< 1	0.22	8.5	53.88	496	0.44	23.0	1.4	0.5	< 1
1611	56-60	7.0	2.0	0.6	< 1	0.25	8.5	60.95	424	0.72	33.0	1.8	0.5	< 1
1612	60-65	7.0	1.0	0.6	< 1	0.14	5.5	72.2	424	0.5	25.0	0.11	0.5	< 1
1613	65-68	20.0	1.0	0.6	< 1	0.16	3.5	32.93	452	0.78	13.0	0.7	0.5	< 1
614	68-69	< 2	1.0	1.0	< 1	1.17	3.5	61.47	332	0.86	10.0	0.6	0.5	< 1

B2-96

[illegible] 9- 73
Date Sent

RESULTS OF DEEP SOIL SAMPLE ANALYSIS

FROM:
Montana Testing Laboratories, I
P. O. Box [illegible]
Great Falls, Montana 59401

To: (Owner) Western Energy Co.
Area B Overburden B51 551

CLIENT: (Dealer)

Lab No.	Your Field No.	Depth	pH	Organic Matter %	Nitrate Nitrogen ppm	Lbs./Ac. N	Phosphorus P ppm	Potassium K ppm	Calcium Ca meq/100g	Magnesium Mg meq/100g	Sodium Na meq/100g	Salt Hazards mmhos	Soil Texture	[illegible] LIME
[illegible]		0-10	8.7	0.1	0.25		0.08	113	34.1	8.0	0.1	0.4	FSL+	M+
[illegible]		11-20	8.6	0.1	0.25		0.80	213	25.5	4.1	0.1	0.3	LFS	M-
[illegible]		21-30	8.7	0.1	0.25		0.08	2.5	19.4	3.4	0.1	0.3	LFS	M-
[illegible]		31-36	8.6	0.1	0.25		0.08	63	25.9	3.2	0.1	0.4	LFS	M
[illegible]		[illegible]	8.8	0.1	0.25		0.50	63	30.2	5.0	0.1	0.5	CL-	M+
[illegible]		[illegible]-47	8.6	0.1	0.25		0.08	83	34.1	4.1	0.1	0.6	FSL+	M+
[illegible]		48-53	8.7	0.1	0.25		0.08	113	28.9	3.4	0.1	0.8	CL+	V
[illegible]		54-56	8.8	0.1	0.25		0.08	113	26.3	3.4	0.1	0.5	LFS	M
[illegible]		57-70	8.5	0.1	0.25		0.08	113	23.6	2.2	0.1	0.8	LFS	M
[illegible]		71-80	8.7	0.1	0.25		0.08	88	27.1	2.5	0.1	0.7	FSL	M+
[illegible]		[illegible]	8.8	0.1	0.25		0.08	188	29.4	2.7	0.1	0.8	FSL+	M+
B2-97		85-87	8.8	0.1	1.25		0.08	113	28.9	2.5	0.1	0.7	L	M+
[illegible]		88-89	8.7	0.8	0.25		0.08	63	32.0	6.2	0.1	0.9	L	M+
[illegible]51		90-91	8.2	5.7	0.5		0.08	113	32.4	5.0	0.1	0.9	L	M

OTHER TESTS REQUIRED

[illegible]	Zinc ppm	Iron ppm	Copper ppm	Manganese ppm	Boron ppm	0.3 ATM	15 ATM	Lime or Gypsum	Cation Exchange Capacity (CEC)	Mechanical Analysis % Clay	% Silt	% Sand	Others
0.6	1.3	4.0	1.8	3.6		15.5	7.75	0.49		25.8	6.4	68.8	SCL
0.6	0.6	4.9	1.2	5.2		7.96	3.98			12.8	4.4	82.8	LS
[illegible].6	1.8	5.8	1.2	5.4		6.8	3.4			10.8	2.4	86.8	LS
21.0	2.6	6.0	1.6	6.1		6.8	3.4	0.39		10.8	2.4	86.8	LS
[illegible].3	25.0	30.0	2.0	10.0		17.24	8.62	0.89		28.8	38.4	32.8	CL-
[illegible].4	20.8	34.4	1.4	13.1		12.6	6.3	0.50		20.8	4.4	74.8	SCL-
[illegible].0	6.0	57.5	2.5	12.4		26.2	13.2	0.61		44.8	16.4	38.8	C-
[illegible].6	6.0	15.2	1.4	8.6		11.44	5.72	0.47		18.8	2.4	78.8	SL
[illegible].9	10.5	[illegible]	1.4	4.2		9.0	4.5	0.38		14.8	0.4	84.8	LS+
[illegible].4	3.0	27.8	4.8	3.2		9.0	4.5	0.39		14.8	0.4	84.8	LS+
[illegible].3	51.2	20.8	2.6	3.4		10.28	5.14	2.6		[illegible]	2.4	[illegible]	SL
[illegible]	[illegible]	29.2	1.4	3.4		7.96	3.98	0.91		12.8	2.4	84.8	LS
[illegible]	[illegible]	30.0	2.0	2.8		17.2	8.6	1.7		28.8	2.4	[illegible]	SCL
[illegible]	[illegible]	[illegible]	5.3	6.2		16.02	8.01	1.05		24.8	2.4	73.8	SCL

WESTERN ENERGY AREA E OVERBURDEN, MICRONUTRIENTS (continued)

Lab No.	Depth	Ba	As	B	Ti	Mo	Sr	SiO_2	F	water sol. F	Hg	Pb	Cd	Al
1638	0-10	17.5	5.0	1.4	< 1	0.07	7.0	58.36	416	0.72	12.0	0.3	< .5	< 1
1639	11-20	11.0	2.0	0.5	< 1	0.12	5.0	64.13	0	0.44	8.0	0.3	< .5	< 1
1640	21-30	7.6	2.4	0.3	< 1	0.06	5.0	50.53	0	0.20	8.0	0.4	< .5	< 1
1641	31-36	5.0	3.5	0.3	< 1	0.07	5.0	60.46	0	0.36	11.0	0.4	< .5	< 1
1642	37-38	5.0	1.0	0.4	< 1	0.22	8.5	44.49	0	0.84	20.0	0.8	< .5	< 1
1643	39-47	2.0	2.2	0.3	< 1	0.1	7.0	67.05	0	0.52	10.0	0.5	< .5	< 1
1644	48-53	5.0	1.5	6.3	< 1	0.19	10.0	33.13	0	0.52	20.0	1.6	< .5	< 1
1645	54-56	5.0	3.0	0.3	< 1	0.16	8.5	42.81	0	0.6	11.0	0.5	< .5	< 1
1646	57-70	2.0	2.0	0.4	< 1	0.22	6.0	57.65	464	0.3	16.0	0.5	< .5	< 1
1647	71-80	5.0	< 1	0.4	< 1	0.32	6.0	65.63	408	0.24	13.0	0.4	< .5	< 1
1648	81-84	3.5	1.1	0.2	< 1	0.22	6.0	49.3	0	0.4	8.0	0.8	< .5	< 1
1649	85-87	2.0	1.6	0.2	1.5	0.22	7.0	44.27	0	0.24	7.0	0.9	< .5	< 1
1650	88-89	6.0	1.0	0.5	< 1	0.25	25.0	54.69	0	0.64	50.0	1.1	< .5	< 1
1651	90-91	5.0	2.0	23.0	< 1	0.1	66.0	59.45	0	1.64	9.0	1.9	1.0	< 1

B2-98

Chemical analyses of core samples in ppm (except Hg in ppb) from overburden samples in Area E N51 E61

APPENDIX C

HYDROLOGY

CONTENT

Hydrologic Terms
Table -1, Spring Date for the Colstrip Area
Table -2, Well Data for the Colstrip Area
Figure -1, Data-Point Numbering System

Hydrologic Terms

Aquifer - The body of porous material such as a formation, group of formations, or part of a formation of sufficient permeability and storage volume to transmit and yield ground water economically in usable quantities to wells and springs.

Artesian Condition - Ground water that is confined under pressure between relatively impermeable or signficantly less permeable material. Water levels in wells completed in artesian aquifers will rise above the top of the aquifer.

Hydraulic Conductivity - A measure of the ease of movement of ground water through aquifers and confining beds. It is expressed as the volume of water at the existing kinematic viscosity that will move through a porous medium in unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of flow. By Darcy's law, the volumetric flow rate Q through an Area A normal to the flow can be expressed as Q/A - K dh/ds, where dh/ds is the hydraulic gradient, the variation in potentiometric head, along the flow path ds. The coefficient K is the hydraulic conductivity and is the permeability of the aquifer multiplied by the specific weight of water divided by the fiscosity of water. The common units are gallons per day per square foot (gpd/ft^2), cubic feet per day per square foot (ft^3/d/ft^2 or ft/day) and cubic centimeters per second per square centimeter (cm^3/s/cm^2 or cm/sec).

Hydraulic Gradient - The variation in the potentiometric surface along a flow line; see hydraulic conductivity.

Natural Recharge - Infiltration of water under natural conditions from land surface to the saturated zone at the water table.

Permeability - The property of a porous medium which allows fluids to flow through it; see hydraulic conductivity. In much of the literature, the term permeability is taken to mean the same as hydraulic conductivity.

Potentiometric Surface - The imaginary surface connecting points to which water would rise in tightly-cased wells from a given point or an aquifer. Potentiometric is preferable to the term piezometric, which was used in the past.

Specific Capacity - The discharge from a well or spring, divided by the drawdown at that particular discharge at a particular time. Normally expressed in gallons per minute per foot (gpm/ft) at a specific discharge rate. This relationship is primarily a function of the aquifer transmissivity and/or the well efficiency. Specific capacity generally decreases at the pumping period increased because the drawdown continually increases with time as the cone of influence of the well expands.

Storage Coefficient - The ability of an aquifer to store water, expressed in numerical terms. It is defined as the volume of water released from or taken into storage per unit surface area of the aquifer by a unit change-in of head. In confined aquifers, the storage coefficient ranges from about 10^{-5} to 10^{-3}; in unconfined aquifers, the storage coefficient is virtually equal to the specific yield or drainable porosity; about 0.05 to 0.40.

Transmissivity - In general, the capacity of an aquifer to transmit water; equal to the horizontal hydraulic conductivity multiplied by the saturated thickness of the aquifer of (approximately) constant thickness. The normal units are: gallons per day per foot (gpd/ft); cubic feet per day per foot (ft^3/d/ft or ft^2/dat; and cubic centimeters per second per foot (cm^3/s/ft or cm^2/sec).

Water Table - Imaginery surface at atmospheric pressure within an unconfined aquifer. It is not bounded above by a confining bed.

TABLE -1

SPRING DATA FOR THE COLSTRIP AREA

Sheet 1 of 4

Location: See Figure D-1 for explanation of well-numbering system.
Altitude: Altitude of land surface at spring, estimated from U.S.G.S. 7.5 min. quad. topo. maps, accurate to 10 feet.
Specific conductance: Field electrical conductance of water, in micromhos per centimeter at 25°C.; "L" indicates laboratory conductance.
Aquifer: Interpretations by MBMG. Coded sources--RO+, more than 150 feet above Rosebud coal; RO, overburden, 0-150 feet above Rosebud coal; Sub Mc, unspecified aquifers stratigraphically below McKay coal.

Location	Altitude (feet)	Date examined	Specific conductance	Estimated discharge (gallons per minute)	Water use	Aquifer	Water analysis
2N. 38E. 03ABBB	3600	-	613	-	Stock	Rosebud coal	
2N. 38E. 03BAAA	3615	6-73	-	3	Stock	Rosebud coal	
2N. 38E. 03CCAO	3520	-	952	2	Stock	Rosebud coal	
2N. 38E. 10DCDC	3520	-	-	-	Stock	RO	
2N. 38E. 11ABBD	3520	-	-	-	Stock	RO	
2N. 38E. 11ADBC	3500	-	-	-	Stock	RO	
2N. 38E. 11DAAC	3480	-	-	-	Stock	RO	
2N. 38E. 11DCCA	3680	-	-	-	Stock	RO+	
2N. 38E. 12CADB	3460	6-73	-	6	Stock	Rosebud coal	
2N. 38E. 13ABBD	3400	-	-	3	Stock	Rosebud coal	
2N. 38E. 34ABBC	3630	7-73	-	1	Stock	RO+	
2N. 38E. 35ACAD	3700	-	-	-	Stock	RO+	
2N. 38E. 36BBBC	3670	7-73	-	-	Stock	RO+	
2N. 38E. 36DCDC	3760	7-73	-	0.5	Stock	RO+	
2N. 39E. 02CABB	3115	-	-	-	Stock	Sub Mc	
2N. 39E. 07BDCB	3380	7-73	-	-	Stock	Sub Mc	
2N. 39E. 08CBAD	3230	7-73	-	-	Stock	Sub Mc	
2N. 39E. 12CCCD	3140	-	-	-	Stock	Sub Mc	
2N. 39E. 14BDBB	3180	-	-	10	Stock	Alluvium	
2N. 39E. 18ABDC	3300	7-73	-	-	Stock	Sub Mc	
2N. 39E. 19DBDA	3435	7-73	-	-	Stock	Sub Mc	

TABLE -1 Sheet 2 of 4

Location	Altitude (feet)	Date examined	Specific conductance	Estimated discharge (gallons per minute)	Water use	Aquifer	Water analysis
2N. 39E. 24BDAB	3210	7-73	-	-	Stock	Sub Mc	
2N. 39E. 2600AA	3295	-	-	-	Stock	Alluvium	
2N. 39E. 31ABAA	3500	10-72	3550	8	Stock	Rosebud coal	yes
2N. 39E. 31CBCO	3620	10-72	-	8	Stock	RO	
2N. 39E. 31CDCC	3620	10-72	-	-	Stock	RO+	
2N. 39E. 31COCO	3620	10-72	-	-	Stock	RO+	
2N. 39E. 36CBAC	3395	-	-	-	Stock	McKay coal	
2N. 39E. 36CBBO	3390	-	-	-	Stock	McKay coal	
2N. 39E. 36CODB	3400	7-73	-	0.5	Stock	McKay coal	
2N. 40E. 17CCBC	3255	-	-	-	Stock	Sub Mc	
2N. 40E. 17COBA	3305	-	-	-	Stock	Sub Mc	
2N. 40E. 18DAAC	3235	-	-	-	Stock	Sub Mc	
2N. 40E. 18DADC	3240	10-72	3550	3.2	Stock	Sub Mc	yes
2N. 40E. 28CCBB	3420	7-75	-	5	Stock	Alluvium	
2N. 40E. 32BBAA	3380	-	-	-	Stock	Rosebud coal	
2N. 40E. 33CC00	3415	-	-	-	Stock	Alluvium	
2N. 41E. 13BBCO	3200	-	-	-	Stock	Alluvium	
2N. 41E. 17AOAO	3120	10-73	2798L	-	Stock	Sub Mc	yes
2N. 42E. 30CCCA	3225	-	-	-	Stock	Rosebud clinker	
2N. 42E. 31CBOC	3160	-	-	-	Stock	Alluvium	
1N. 38E. 020ADD	3920	-	-	-	Stock	RO+	
1N. 38E. 03AACC	3710	-	-	-	Stock	RO+	
1N. 38E. 03ACDC	3660	8-73	4320	-	Stock	RO+	
1N. 38E. 03ADCC	3680	-	-	-	Stock	RO+	
1N. 38E. 10BBDC	3540	-	2050	1	Stock	RO	
1N. 38E. 11CCDD	3660	8-73	-	-	Stock	RO+	
1N. 38E. 11DBBC	3743	8-73	5840	0.1	Stock	RO+	

Location	Altitude (feet)	Date examined	Specific conductance	Estimated discharge (gallons per minute)	Water use	Aquifer	Water analysis
1N. 38E. 12CDCA	3850	-	-	-	Stock	RO+	
1N. 38E. 13AADA	3830	8-73	1860	0.5	Stock	RO+	
1N. 38E. 13BABB	3820	-	-	-	Stock	RO+	
1N. 38E. 13BCBA	3755	-	-	-	Stock	RO+	
1N. 38E. 14CBCB	3540	-	-	-	Stock	RO+	
1N. 38E. 15BBDA	3550	8-73	2830L	0.1	Stock	Rosebud coal	yes
1N. 38E. 15BCCD	3415	8-73	7320	-	Stock	Sub Mc	
1N. 38E. 15DAAD	3460	-	-	-	Stock	RO	
1N. 39E. 06ADDA	3690	7-73	-	-	Stock	RO+	
1N. 39E. 08CDDA	4160	7-73	-	-	Stock	RO+	
1N. 39E. 09DDAA	3920	7-73	-	-	Stock	RO+	
1N. 39E. 10BABB	3790	-	-	-	Stock	RO+	
1N. 39E. 11BBDD	3940	-	-	-	Stock	RO+	
1N. 39E. 14BBAB	3820	10-73	-	-	Stock	RO+	
1N. 39E. 17AACB	4260	10-73	-	-	Stock	RO+	
1N. 39E. 18ADCC	4175	10-73	-	-	Stock	RO+	
1N. 39E. 18ADDD	4330	10-73	-	-	Stock	RO+	
1N. 39E. 18BDBC	4020	-	-	-	Stock	RO+	
1N. 39E. 18BDCB	4000	8-73	-	2	Stock	RO+	
1N. 39E. 23CCBB	3990	-	-	-	Stock	RO+	
1N. 39E. 24ABCC	3780	-	-	-	Stock	RO+	
1N. 40E. 02BABD	3440	7-73	2930L	0.3	Stock	Rosebud coal	yes
1N. 40E. 02BBDD	3450	7-73	-	-	Stock	Rosebud coal	
1N. 40E. 02BDAB	3450	7-73	-	-	Stock	Rosebud coal	
1N. 40E. 04CAAA	3435	-	-	-	Stock	Rosebud coal	
1N. 40E. 19DCCD	3630	9-73	2090L	1	Stock	RO+	yes
1N. 40E. 20DADC	3515	9-73	-	0.3	Stock	RO	
1N. 40E. 27DCDD	3350	-	-	-	Stock	RO	
1N. 40E. 30ABBC	3610	9-73	-	3	Stock	RO+	

TABLE -1 Sheet 4 of 4

Location	Altitude (feet)	Date examined	Specific conductance	Estimated discharge (gallons per minute)	Water use	Aquifer	Water analysis
1N. 40E. 30ACDC	3610	9-73	-	3	Stock	RO+	
1N. 40E. 31DBDA	3610	7-73	-	1	Stock	RO+	
1N. 40E. 32ADDB	3490	-	-	-	Stock	RO+	
1N. 41E. 24CCAA	3130	-	-	-	Stock	Alluvium	
1S. 40E. 03BBAD	3510	-	-	-	Stock	RO+	
1S. 40E. 06BBDB	3890	9-73	1640	0.2	Stock	RO+	yes
1S. 40E. 07CBCD	3675	9-73	-	0.2	Stock	RO+	
1S. 40E. 08AADB	3600	9-73	2400	2	Stock	RO+	yes
1S. 40E. 09DADC	3475	-	-	-	Stock	RO+	
1S. 40E. 12DDDA	3480	7-73	692L	0.5	Stock	RO+	yes

TABLE -2

Sheet 1 of 6

WATER-WELL DATA FOR THE COLSTRIP AREA, SOUTHEASTERN MONTANA

Location: See Figure D-1 for explanation of well-numbering system.
Altitude: Altitude of land surface at well, estimated from U.S.G.S. 7.5 min. quad. topo. maps; accurate to 10 feet.
Depth to water: Depths to nearest 0.1 foot measured; depths to nearest 1.0 foot reported; "F" indicates flowing well.
Specific conductance: Field electrical conductance of water, in micromhos per centimeter at 25°C.; "L" indicates laboratory conductance.
Aquifer: Interpretations by MBMG. Coded sources--RO+, more than 150 feet above Rosebud coal; RO, overburden, 0-150 feet above Rosebud coal; Sub Mc, unspecified aquifers stratigraphically below McKay coal.

Location	Altitude (feet)	Well depth (feet)	Depth to water (feet)	Date examined	Specific conductance	Temperature (ºC.)	Water use	Aquifer	Water analysis
2N. 38E. 15ADDA	3540	-	-	7-73	1840	-	Stock	Sub Mc	
2N. 38E. 15CCDC	3500	-	-	7-73	1232L	-	Stock	Sub Mc	yes
2N. 38E. 24BCBC	3530	-	-	-	1290	-	Stock	Alluvium	
2N. 38E. 25CDDC	3640	-	150	-	-	-	Stock	Rosebud coal	
2N. 38E. 26AABA	3650	226	166.8	10-73	-	-	Stock	Sub Mc	
2N. 38E. 36CDBD	3766	-	60	-	-	-	Stock	RO+	
2N. 39E. 03CDBB	3195	113	61.0	9-73	-	-	Stock	Sub Mc	
2N. 39E. 05BCBA	3205	57	-	9-73	2400	11.0	Stock	Sub Mc	yes
2N 39E. 05DDDC	3170	16	15.2	9-73	6638L	13.3	Stock	Alluvium or Sub Mc	yes
2N. 39E. 06CBBB	3320	-	-	-	-	-	Stock	Sub Mc	
2N. 39E. 08AABB	3170	-	-	-	-	-	Stock	Sub Mc	
2N. 39E. 10BBCA	3245	130	75	-	-	-	Stock	Sub Mc	
2N. 39E. 12CCC$_1$	3160	555	-	11-72	1200	13.5	House	Tullock	yes
2N. 39E. 12CCC$_2$	3150	71	35	-	-	-	Stock	Sub Mc	
2N. 39E. 12CCDB	3130	20	17	-	-	-	Stock	Alluvium	
2N. 39E. 14BCDB	3180	240	-	7-75	3150	-	House	Sub Mc	
2N. 39E. 16ACDD	3260	100	35	-	-	-	Stock	Sub Mc	
2N. 39E. 17DCAA	3320	-	-	8-75	-	-	Stock	Sub Mc	
2N. 39E. 19CACB	3468	-	-	-	-	-	Stock	Unknown	
2N. 39E. 20DBCB	3457	-	-	8-75	-	-	Stock	Unknown	
2N. 39E. 23CAAB	3350	-	98.7	7-73	1450	27.0	Stock	Sub Mc	yes
2N. 39E. 24CDAB	3250	140	50	7-73	3030L	-	Stock	Sub Mc	yes
2N. 39E. 24CDDD	3240	46	18.1	7-73	-	-	Unused	Sub Mc	
2N. 39E. 25ACDC	3280	136	58	7-73	5060L	-	Stock	Sub Mc	yes
2N. 39E. 27CCCC	3430	262	127.8	7-73	-	-	Stock	Sub Mc	
2N. 39E. 28CABD	3375	-	-	8-75	-	-	Unused	Unknown	
2N. 39E. 29BCCC	3456	-	-	8-75	-	-	-	Unknown	

Location	Altitude (feet)	Well depth (feet)	Depth to water (feet)	Date examined	Specific conductance	Temperature (°C.)	Water use	Aquifer	Water analysis
2N. 39E. 3CCBAA	3555	-	-	-	-	-	Stock	Unknown	
2N. 39E. 31CBAA	3550	128	35.9	7-75	-	-	Stock	Rosebud coal or RO	
2N. 39E. 31CCBA	3625	220	73.1	7-75	-	-	Stock	Rosebud coal	
2N. 39E. 32CCCD	3520	-	-	7-73	3500	12.5	Stock	Unknown	yes
2N. 39E. 34ADBB	3435	60	27	11-72	2940L	-	House	Rosebud coal	yes
2N. 39E. 34DADB	3470	80	26.9	7-73	2050L	16.0	Stock	Rosebud coal	yes
2N. 40E. 01AAAA	3145	117	93	8-75	-	-	Stock	Tullock	
2N. 40F. 02DACB	3205	69	29.3	8-75	-	-	Unused	Sub Mc	
2N. 40E. 04BBAA	3270	84	30	-	-	-	Stock	Sub Mc	
2N. 40E. 06ABAB	3190	86	70	-	-	-	Stock	Sub Mc	
2N. 40E. 06ABAC	3200	143	84	-	-	-	Stock	Sub Mc	
2N. 40E. 06ABBA	3190		40	-	2400	-	House	Sub Mc	
2N. 40E. 06CBCB	3160	104	84	7-73	3000	10.5	Stock	Sub Mc	yes
2N. 40E. 07BDCC	3210	128	80	7-73	-	-	Stock	Sub Mc	
2N. 40E. 10BBCD	3282	210	145	-	-	-	Stock	Sub Mc	
2N. 40E. 11AABA	3241	130	60	-	-	-	Stock	Sub Mc	
2N. 40E. 12AAAB	3260	165	30	-	-	-	House	Sub Mc	
2N. 40E. 17AACA	3440	184	165	-	-	-	Stock	Sub Mc	
2N. 40E. 17ABOD	3480	185	80	-	-	-	Stock	Sub Mc	
2N. 40E. 240BDC	3220	85	60	-	-	-	House	Sub Mc	
2N. 40E. 240CBA	3220	30	22	-	-	-	Stock	Alluvium	
2N. 40E. 25BABA	3245	80	60	-	-	-	Stock	Sub Mc	
2N. 40E. 26BADB	3274	-	-	-	-	-	Stock	Sub Mc	
2N. 40E. 28AAOD	3370	146	75.7	7-75	3510	12.0	Stock	Sub Mc	
2N. 40E. 29CCDC	3380	-	F	7-75	2820	16.0	Stock	Sub Mc	
2N. 40E. 3CBAAO	3275	246	72	7-73	3500	14.0	Stock	Sub Mc	yes
2N. 40E. 31DCCO	3530	165	113.6	11-72	1750	13.0	Stock	Rosebud coal and McKay coal	yes
2N. 40E. 32CBAB	3390	-	-	7-73	950	-	House	Sub Mc	yes
2N. 40E. 32BBCA	3430	67	23.3	7-73	-	-	Unused	Rosebud clinker	
2N. 40E. 33A000	3360	140	100	-	-	-	Stock	Sub Mc	
2N. 40E. 35DDCO	3425	250	148.2	7-73	2800	11.5	Stock	Sub Mc	yes
2N. 41E. 01DBBA	3140	-	61.7	8-73	878L	11.5	Stock	Sub Mc	yes
2N. 41E. 02ACDC	3160	10	3	8-73	-	-	Stock	Alluvium	
2N. 41E. 02DBBA	3170	220	-	11-72	3290L	-	House	Sub Mc	yes
2N. 41E. 08ACCO	3182	-	-	10-73	-	-	Stock	Sub Mc	
2N. 41E. 10BCBC	3175	150	100	7-73	1825	13.0	Stock	Sub Mc	yes
2N. 41E. 12CCAD	3178	-	-	-	-	-	Stock	Sub Mc	

TABLE -2 Sheet 3 of 6

Location	Altitude (feet)	Well depth (feet)	Depth to water (feet)	Date examined	Specific conductance	Temperature (oC.)	Water use	Aquifer	Water analysis
2N. 41E. 17ADAA	3121	110	-	10-73	2390L	12.0	House	Sub Mc	yes
2N. 41E. 20DDCD	3224	70	22.6	8-75	-	-	Stock	Sub Mc	
2N. 41E. 21CADA	3165	122	29.7	11-72	3460L	10.0	Public	Sub Mc	yes
2N. 41E. 21[illegible]D	3240	120	40.3	8-75	3830	11.0	Stock	Sub Mc	
2N. 41E. 22BAAB	3260	68	57	-	-	-	Stock	Sub Mc	
2N. 41E. 24CAAC	3450	27	23.6	7-73	-	-	Stock	RO	
2N. 41E. 24CABA	3460	18	-	7-73	-	-	House	RO	
2N. 41E. 27CCBC	3219	-	-	-	-	-	Stock	Alluvium or Sub Mc	
2N. 41E. 30DDAA	3360	-	-	10-73	3076L	13.0	Stock	Unknown	yes
2N. 41E. 32DABB	3420	300	140	-	-	-	Stock	Sub Mc	
2N. 41E. 33DAAA	3270	519	315	-	-	-	Public	Tullock	
2N. 41E. 33DAAD$_1$	3270	1520	60	-	-	-	Public	Hell Creek	
2N. 41E. 33DAAD$_2$	3270	596	203	-	-	-	Public	Tullock	
2N. 41E. 34BADC	3120	9336	-	-	-	-	Public	Madison	
2N. 41E. 34BCBB	3260	614	-	-	-	-	Public	Tullock	
2N. 42E. 04DACA	3003	102	60	8-73	2058L	11.5	Stock	Sub Mc	yes
2N. 42E. 05CABB	3077	-	56.5	8-73	2072L	11.0	Stock	Sub Mc	yes
2N. 42E. 06CBDC	3140	120	87.3	11-72	1950	12.0	Stock	Sub Mc	yes
2N. 42E. 07DCAD	3135	-	-	-	-	-	-	Sub Mc	
2N. 42E. 09CCBA	3097	-	-	-	-	-	-	Sub Mc	
2N. 42E. 20CDAD	3195	115	-	11-72	-	-	Stock	Sub Mc	
2N. 42E. 30CDCB	3245	200	-	-	-	-	Stock	Sub Mc	
2N. 42E. 32DBCC	3130	100	-	-	-	-	Stock	Sub Mc	
1N. 38E. 10ADCA	3679	-	-	-	-	-	Stock	RO+	
1N. 38E. 11BBCB	3740	-	34.7	8-73	5040	-	Stock	RO+	
1N. 38E. 13CDCC	3660	-	-	-	-	-	Stock	RO+	
1N. 39E. 01BBBA$_1$	3460	84	30	-	-	-	Stock	Sub Mc	
1N. 39E. 01BBBA$_2$	3476	96	39.9	7-73	-	-	Stock	Sub Mc	
1N. 39E. 02BBBB	3535	-	-	-	-	-	Stock	Unknown	
1N. 39E. 04AABC	3537	-	-	-	-	-	Stock	Unknown	
1N. 39E. 04DBCC	3643	-	-	-	-	-	Stock	Unknown	
1N. 39E. 05CBBA	3690	300	-	-	3000	12.0	Stock	RO+	yes
1N. 39E. 05CBBB	3745	-	-	-	-	-	Stock	Unknown	
1N. 39E. 10BBBB	3770	-	-	-	-	-	Stock	Unknown	
1N. 39E. 11ADAD	3860	-	-	-	-	11.0	Stock	Unknown	
1N. 39E. 12CCCC	3735	-	-	-	-	9.0	Stock	Unknown	
1N. 39E. 15BDAD	3910	-	-	-	-	-	Stock	Unknown	

Location	Altitude (feet)	Well depth (feet)	Depth to water (feet)	Date examined	Specific conductance	Temperature (°C.)	Water use	Aquifer	Water analysis
1N. 39E. 23CAAA	3890	-	-	-	-	-	Stock	Unknown	
1N. 39E. 24BBBC	3826	122	62	9-73	2423L	12.0	Stock	RO+	yes
1N. 39E. 25ABBC	3578	375	-	-	-	-	Stock	RO+	
1N. 40E. 01CCCD	3418	80	34.1	7-73	-	-	Stock	RO	
1N. 40E. 02BBDC	3510	44	34.1	7-73	520	9.0	House	RO	yes
1N. 40E. 02CDCC	3512	100	42.2	10-73	1250L	11.0	Stock	Rosebud coal	yes
1N. 40E. 04DADB	3505	-	-	-	-	-	Stock	Unknown	
1N. 40E. 04DBBA	3440	200	75	-	-	-	Stock	Sub Mc	
1N. 40E. 05CCCB	3530	115	85.3	-	-	-	Stock	Rosebud coal or RO	
1N. 40E. 06ABBB	3520	128	40	-	-	-	Stock	Rosebud coal and McKay coal	
1N. 40E. 07BCBB	3720	143	84.3	-	-	-	Stock	RO+	
1N. 40E. 10DAAB	3470	132	50	-	-	-	Stock	McKay coal	
1N. 40E. 11ABBB	3558	-	-	10-73	-	-	-	Unknown	
1N. 40E. 12CBAA	3400	40	35.4	9-73	1700	10.5	Stock	Alluvium	yes
1N. 40E. 13ABAA	3426	-	-	10-73	2298L	11.0	Stock	Unknown	yes
1N. 40E. 14BBBB$_1$	3438	-	-	10-73	1542L	10.0	Stock	Unknown	yes
1N. 40E. 14BBBB$_2$	3438	-	-	10-73	1344L	-	House	Unknown	yes
1N. 40E. 15BBCB	3480	-	-	9-73	1520L	11.0	Stock	Unknown	yes
1N. 40E. 16DBAA	3520	-	42.8	9-73	-	-	Unused	Rosebud coal or RO	
1N. 40E. 17BAAA	3560	-	-	-	-	-	Stock	Unknown	
1N. 40E. 18ABBB	3640	-	-	7-73	-	-	House	Unknown	
1N. 40E. 18BABA	3630	-	-	-	-	-	Stock	Unknown	
1N. 40E. 18DDDC	3654	50	23	9-73	-	-	Unused	RO+	
1N. 40E. 21AAAD	3548	120	106.4	9-73	-	-	Unused	Rosebud coal	
1N. 40E. 23BDDB	3420	100	30	-	-	-	Stock	Rosebud coal	
1N. 40E. 24CACB	3380	66	35.3	9-73	-	-	Stock	Rosebud coal or RO	
1N. 40E. 26CABB	3423	-	-	-	-	-	Stock	Unknown	
1N. 40E. 28ADDD	3415	74	35.4	9-73	-	-	Stock	RO	
1N. 40E. 29ACBB	3550	232	80	9-73	2756L	10.5	Stock	Sub Mc	yes
1N. 40E. 34DCBB	3595	-	-	-	-	-	Stock	Unknown	
1N. 40E. 35CAAD	3298	-	-	-	-	-	Stock	Unknown	
1N. 40E. 36BACD	3440	104	85	9-73	-	-	Stock	RO	
1N. 41E. 02DACC	3330	141	76	-	-	-	Stock	Rosebud coal and McKay coal	
1N. 41E. 03BBBB	3240	55	45	-	-	-	Stock	McKay coal	
1N. 41E. 03CDDD	3330	86	67.4	8-73	1600	11.5	Stock	RO	yes
1N. 41E. 04DDBA	3330	-	-	-	-	-	Stock	Unknown	
1N. 41E. 06ACAB	3470	-	-	-	-	-	Stock	Unknown	
1N. 41E. 06DDDB	3365	-	-	-	-	-	Stock	Unknown	
1N. 41E. 07DBBA	3360	125	100	10-73	1160L	11.0	Stock	Sub Mc	yes

TABLE -2

Sheet 5 of 6

Location	Altitude (feet)	Well depth (feet)	Depth to water (feet)	Date examined	Specific conductance	Temperature (°C.)	Water use	Aquifer	Water analysis
1N. 41E. 08BBDB	3320	50	-	-	-	-	Stock	Alluvium	
1N. 41E. 08DBDC	3320	389	-	3-73	2510L	13.0	House	Sub Mc	yes
1N. 41E. 08BBDD	3320	50	-	-	-	-	Stock	Alluvium	
1N. 41E. 08CBAB$_1$	3357	100	-	10-73	776L	11.0	Stock	Rosebud coal	yes
1N. 41E. 08CBAB$_2$	3345	18	-	10-73	-	-	Unused	Alluvium	
1N. 41E. 12CBDB	3160	51+	-	8-73	3000	15.5	Stock	Unknown	yes
1N. 41E. 13CCCD	3290	200	108.9	11-72	2150	16.0	Irrigation	Sub Mc	yes
1N. 41E. 17CCBB	3390	-	-	-	-	-	Stock	Unknown	
1N. 41E. 23CCDC	3730	74+	44.9	8-73	2544L	19.0	Industrial	Sub Mc	yes
1N. 41E. 23CCAD	3260	300	190	-70		-	House	Sub Mc	
1N. 41E. 24DDBB	3150	30+	13.8	8-73	-	-	Stock	Sub Mc	
1N. 41E. 25DDBB	3085	60+	38.3	8-73	-	-	Stock	Sub Mc	
1N. 41E. 26BCAB	3190	195	23.5	8-73	-	-	Unused	Sub Mc	
1N. 41E. 30BBCD	3328	90	30	9-73	-	-	Stock	Rosebud coal	
1N. 41E. 31AADA	3255	153	83.3	9-73	-	-	Stock	Sub Mc	
1N. 41E. 33BCCB	3190	65	22.0	9-73	-	-	Stock	Sub Mc	
1N. 42E. 07CBBD	3260	940	-	2-72	-	-	Fire	Hell Creek	
1N. 42E. 19DBBA	3128	67	22.7	8-73	1600	11.0	Stock	McKay coal	yes
1N. 42E. 26BDDC	3010	53	17.8	8-73	1906L	10.0	Stock	Sub Mc	yes
1N. 42E. 31BBBC	3090	-	-	8-73	-	-	Stock	Sub Mc	
1N. 42E. 32DADD	2990	80	33.7	8-73	-	-	Stock	Sub Mc	
1N. 42E. 33ADBC	2970	42	24.2	9-72	3200	10.0	Stock	Sub Mc	yes
1N. 42E. 33BDCA	2990	91	57	8-73	-	-	Stock	Sub Mc	
1S. 40E. 02CACC	3415	-	-	-	-	-	Stock	Unknown	
1S. 40E. 03BACD	3500	-	-	-	-	-	Stock	Unknown	
1S. 40E. 05CDAD	3660	-	-	9-73	-	-	Stock	RO+	
1S. 40E. 06DADA	3757	150	120	9-73	-	-	Stock	RO+	
1S. 40E. 07DADA	3580	420	220	7-73	2906L	13.0	Stock	RO	yes
1S. 40E. 09DADB	3485	44	41.5	7-73	-	-	Stock	RO+	
1S. 40E. 14DCBD	3327	62	50.4	9-73	-	-	Stock	RO+	
1S. 40E. 16DABD	3410	65	60	7-73	-	-	Stock	RO+	
1S. 41E. 01DDBA	3105	54	38	9-73	-	-	Stock	Sub Mc	
1S. 41E. 02AABB	3150	81	26.5	7-73	2348L	-	Stock	Sub Mc	yes
1S. 41E. 05CADC	3220	150	105	-	-	-	Stock	Sub Mc	
1S. 41E. 06AAAC	3250	-	-	-	-	-	Stock	Unknown	
1S. 41E. 09CABC	3165	-	-	-	-	-	Stock	Unknown	
1S. 41E. 11DBCC	3130	-	-	-	-	-	Stock	Unknown	

TABLE -2 Sheet 6 of 6

Location	Altitude (feet)	Well depth (feet)	Depth to water (feet)	Date examined	Specific conductance	Temperature (ºC.)	Water use	Aquifer	Water analysis
1S. 41E. 13CCCB	3060	60	14	-	-	-	Stock	Sub Mc	
1S. 41E. 14BDDD	3060	80	14	-	-	-	House	Sub Mc	
1S. 41E. 14CCCB	3050	76	26.5	7-73	-	-	Stock	Sub Mc	
1S. 41E. 15CCCA	3091	71	-	-	-	-	Stock	Sub Mc	
1S. 41E. 17DAAD	3169	45	24	-	2450	10.5	Stock	Sub Mc	yes
1S. 42E. 03BBDC	2290	-	-	-	-	-	-	Alluvium or Sub Mc	
1S. 42E. 04DCA$_1$	3010	38	26.6	8-73	5250	11.5	Irrigation	Alluvium	yes
1S. 42E. 04DCA$_2$	3010	40	22.2	8-73	4500	13.0	Irrigation	Alluvium	yes
1S. 42E. 05ADBB	3070	-	-	-	-	-	-	Sub Mc	
1S. 42E. 07AACB	3040	-	-	-	-	-	-	Alluvium or Sub Mc	
1S. 42E. 08DAAC	3055	-	-	-	-	-	-	Sub Mc	
1S. 42E. 09ACDC	3040	-	-	-	-	-	-	Sub Mc	
1S. 42E. 16ACCA	3090	-	-	-	-	-	-	Sub Mc	
1S. 42E. 17DDDB	3196	-	-	-	-	-	-	Sub Mc	

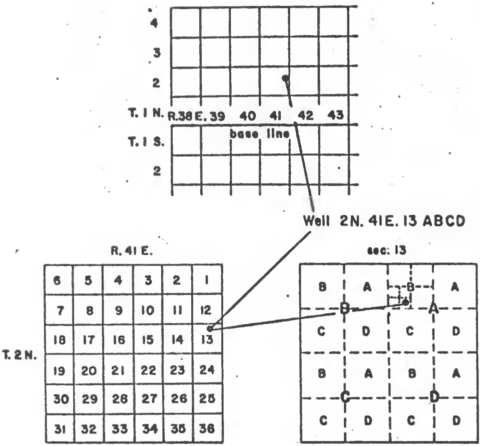

FIGURE -1

DATA - POINT NUMBERING SYSTEM

APPENDIX D-1

DETAILED DESCRIPTION OF COMMUNITY TYPES IN AREAS A AND E

Plant Community Descriptions:

Taken from: Ecological Consulting Service 1975. Western Energy Vegetation Production, Condition and Community Typing. Mining areas A, B and E. Project 107.23.A. Helena, Montana. 38 pp.

Grassland Communities:

Agropyron smithii-Bromus spp.-Poa. spp. (111.1)

This community was present on mesic bottomlands of heavy soils. The SCS range site for this type was classed as overflow (USDA 1971), which is characterized by low mesic bottomland.

Dominant grass species in this community were western wheatgrass (Agropyron smithii), Japanese chess (Bromus japonicus), Kentucky bluegrass (Poa pratensis), and green needlegrass (Stipa viridula). The type was similar to Plant Community 220.

Agropyron smithii-Koeleria cristata-Carex filifolia

(111.2)

This plant community occurred adjacent to the community previously discussed but at slightly higher elevations. Gradients were not much different as it usually was found on low benches, but sites were slightly more xeric than at sites occupied by Plant Community 111.1. At times it appeared to be an ecotone between Plant Communities 111.1 and 111.3

Dominant grass species found in this community were western wheatgrass, Japanese chess, junegrass (Koeleria cristata), green needlegrass, cheatgrass (Bromus tectorum), and threadleaf sedge (Carex filifolia). Western wheatgrass was found at all sites. Green needlegrass occurred in transects conducted closest to Plant Community 111.1. Junegrass and blue grama were found in transects in closer proximity to Plant Community 111.3

Stipa comata-Carex filifolia-Koeleria cristata (111.3)

Upper benches, knolls, and ridges not dominated by shrubs or timber were sites where this plant community occurred. This was a common plant community and was rather widespread in the areas of study. Sindelar (1972) described a similar range type. This community would probably be more extensive if not for past disturbance. It generally occurred at gradients above that of Plant Community 111.2 in more xeric soils.

The three most common grasses were needle-and-thread (Stipa comata), threadleaf sedge, and junegrass. Needle-and-thread was found in every transect. Japanese chess, cheatgrass, and red three-awn (Aristida longiseta) were also found in this plant community.

Calamovilfa longifolia-Andropogon spp. (111.4)

This community occurred as localized patches on knolls and on footslopes of ridges. It was generally found in close association with sandy soils and appeared to occur on any exposure near the top of knolls or ridges.

Prairie sand reedgrass (Calamovilfa longifolia) and little bluestem (Andropogon scoparius) were dominant grasses. Big bluestem (Andropogon gerardii) occurred at some sites along with junegrass and needle-and-thread. Some sites tended to be dominated more by little bluestem and others by prairie sand reedgrass.

Bromus tectorum (111.5)

This community occurred as isolated sites wherever the other natural types were disturbed or severely overgrazed. It occurred more often in Plant Communities 111.2 and 111.3 as well as in shrub-grassland communities such as Plant Community 213. It was often found on south-facing slopes that "green up" early in the spring and hence are sought out and overgrazed by livestock. It also occurred near windmills where livestock gather for water. It could occur in any natural plant community. It was characterized by dense stands of cheatgrass.

Shrub-grassland Communities:

Artemisia tridentata-Koeleria cristata-Agropyron spicatum (211)

Upper slopes and benches were common sites where this plant community was found. Soils of this community were fine and clayey. Often times this plant community appeared to be overgrazed.

Big sagebrush (Artemisia tridentata) was the dominant shrub and appeared to be very scrubby. Common grasses were junegrass, which appeared in every transect, and bluebunch wheatgrass (Agropyron spicatum). Western wheatgrass, Japanese chess, blue grama, and sandberg bluegrass (Poa secunda) were other common grasses.

Artemisia cana-Agropyron smithii-Stipi viridula-Poa spp. (212.1)

This plant community characteristically occupied the moist drainage channels in the areas of study and was typically associated with the moist, coarser soils of alluvial overflow sites (Parker 1970). It was generally found in mesic draws and coulees. Sindelar (1972) described a similar range type. It was usually bordered by Plant Communities 111.1 or 212.2.

Silver sagebrush was the dominant shrub and occurred in very dense stands. Common grasses were western wheatgrass, green needlegrass, and bluegrasses (Poa spp.). At times, Japanese chess occurred also.

Artemisia cana-Agropyron smithii-Stipi viridula-Bromus spp. (212.2)

This plant community was found on lower benches adjacent to swales and coulees inhabited by Plant Community 212.1. The SCS range site classification was silty compared to overflow for Plant Community 212.1 (USDA 1971). The dominant shrub in this community was silver sagebrush, but was found in sparse stands in comparison to the dense stands in

Plant Community 212.1. Grasses indigenous to this type were similar to Plant Community 212.1 and consisted of western wheatgrass, green needlegrass, cheatgrass, and Japanese chess.

Rhus trilobata-Stipa comata-Agropyron smithii (213)

This plant community occurred often near and within stands of ponderosa pine (Pinus ponderosa) (Martin 1973). At other sites it was found as a distinct shrub-grassland community with no close association with stands of ponderosa pine. It was found in sandy soils on ridges, knolls, or south-facing slopes. Other sites where this community was found was near sandstone outcrops or on flat benches surrounded by ponderosa pine. Since it was often found on south-facing slopes, cheatgrass was quite common at these sites, again due to the early "green up" and associated overgrazing by livestock.

Skunkbush sumac (Rhus trilobata) was the most dominant shrub. Common grasses were western wheatgrass, needle-and-thread, junegrass, prairie sand reedgrass, bluebunch wheatgrass, and cheatgrass.

Chrysothamnus nauseosus-Agropyron spicatum-Oryzopsis hymenoides (214)

This community generally occurred on isolated knobs and knolls in conjunction with unstable clay gumbos. It also occurred on very steep gumbo slopes. This type was not very extensive in size but could be found throughout the areas of study. The SCS range site was determined to be a dense clay site (USDA 1971). Vegetation was very sparse.

Rubber rabbitbrush (Chrysothamnus nauseosus) was the most common shrub. Other shrubs that occurred in this type was shadscale saltbush (Atriplex confertifolia), broom snakeweed, and big sagebrush. Bluebunch wheatgrass and Indian ricegrass (Oryzopsis hymenoides) were the two most common grasses. Western wheatgrass was also found at some sites.

Timber-grassland Communities:

Acer negundo-Fraxinus pennsylvanica-Poa spp.-Agropyron smithii (220)

This plant community occurred along creek bottoms. The major creek in the area of study was the upper east fork of Armell's Creek. The overstory consisted of box elder (Acer negundo) and green ash (Fraxinus pennsylvanica). A few plains cottonwoods (Populus deltoides) could also be found. The understory of this community was very similar to Plant Community 111.1. Common grasses consisted of Kentucky bluegrass and western wheatgrass. At other sites, shrubs such as prairie rose (Rosa arkansana) and snowberry (Symphoricarpos spp.) occurred in the understory. This type was limited in extent in the area of study, and most of it had been disturbed by the extensive construction of new mining facilities that border the east fork of Armell's Creek.

Pinus ponderosa-Agropyron spicatum (351)

This plant community occurred at higher elevations along ridges and sandstone outcrops within the study area. At some sites this community occurred along coulees leading away from the ridges. The soils were classed as thin-hilly by SCS criteria (USDA 1971). The overstory aspect of the type varied from a near closed canopy "woods" to a very open canopy "savanna" of scattered trees. The understory varied inversely with the overhead canopy in regard to cover. In areas of open canopy the understory was well developed, and in areas of closed canopy the understory was generally sparse and poorly developed.

Kuchler (1964) described the entire Colstrip vicinity as an eastern ponderosa pine vegetation formation. Pfister, et al. (1973) described the area as a Pinus ponderosa/Agropyron spicatum habitat type within a Pinus ponderosa series.

Ponderosa pine was the most common tree. Rocky Mountain juniper (Juniperus scopulorum) occurred in limited fashion. Common grasses consisted of bluebunch wheatgrass, threadleaf sedge, needle-and-thread, and junegrass. Skunkbush sumac was a common shrub.

Pinus ponderosa-Juniperus scopulorum-Agropyron spicatum (352)

This community occurred on ridges at high elevations. It was very limited in extent in the areas of study and was usually found on steep north-facing slopes.

Rocky Mountain juniper was the most common tree. Ponderosa pine occurred in limited fashion. Like Plant Community 351, the understory varied from barren areas to quite shrubby areas inversely dependent on the overstory canopy. This plant community was generally more open in regard to overstory canopy than Plant Community 351. The most common grass was bluebunch wheatgrass. Other grass species included Japanese chess, sideoats grama (Bouteloua curtipendula), and plains muhly (Muhlenbergia cuspidata). Common shrubs were big sagebrush, skunkbush sumac, and rubber rabbitbrush.

Non-natural Plant Communities:

Agricultural (530)

Sites disturbed by man for agricultural purposes, such as fields of winter wheat, its associated fallow and alfalfa, were classed as agricultural plant communities.

Stock Ponds (543)

These sites consisted of stock watering ponds created by the damming of drainages for the purpose of providing water for domestic livestock.

Disturbed Grassland (651)

This plant community occurred wherever man disturbed the natural plant communities in the past by plowing. These sites varied in grass species present due to the successional response over the number of years since disturbance. Recent sites were dominated by crested wheatgrass (Agropyron cristatum). Native grasses such as western wheatgrass and needle-and-thread occurred on apparently older sites. Invading annuals such as cheatgrass and Japanese chess were also found at these sites.

Roadways (652)

This type consisted of county roads, highways, railroads, and their associated borrow areas.

Residential Areas (653)

These sites were very limited in extent and consisted of farm and ranch yards, corrals and other disturbed areas used to park farm equipment.

APPENDIX D-2

DESCRIPTION OF ACREAGES AND PRODUCTIVITY OF BURLINGTON-NORTHERN CROPLANDS IN AREA A AND PRODUCTIVITY DATA FOR COMMUNITY TYPES IN AREA E

BURLINGTON NORTHERN

AGRICULTURAL RESOURCES
DEPARTMENT

P.O. Box 579
Miles City, Montana 59301
Telephone (406) 232 1274

March 23, 1977

Mr. Dana C. Schmidt
c/o Olson-Elliott & Associates
P. O. Box 1209
349 Last Chance Gulch
Helena, Montana 59601

Re: Your letter dated March 16, 1977

Dear Mr. Schmidt:

Here is the information you requested in the above referenced letter.

Section 5, Township 1 North, Range 41 East, MPM

1976: 94.3 ac. winter wheat, average yield-32.0 bu/ac.
70.9 ac. alfalfa, average yield-1.7 ton/ac.
14.0 ac. alfalfa-grass mix, average yield-.74 ton/ac.
76.9 ac. summer fallow

1975: 76.9 ac. winter wheat, average yield-30.6 bu/ac.
98.1 ac. alfalfa, average yield-1.9 ton/ac.
14.0 ac. alfalfa-grass mix, cash leased, no yield data
94.3 ac. summer fallow

1974: 94.3 ac. winter wheat, average yield-35.4 bu/ac.
98.1 ac. alfalfa, average yield-1.2 ton/ac.
14.0 ac. alfalfa-grass hay, cash leased
76.9 ac. summer fallow

1973: 76.9 ac. winter wheat, average yield-28.8 bu/ac.
15.0 ac. oats, average yield-26.6 bu/ac.
104.7 ac. oats & alfalfa hay, average yield-.95 ton/ac.
23.5 ac. alfalfa grass hay, cash leased
94.3 ac. summer fallow

1972: 167.8 ac. winter wheat, average yield-20.3 bu/ac.
76.6 ac. oats & alfalfa, no yield data (new seeding)
23.5 ac. grass, cash leased
76.9 ac. summer fallow

BURLINGTON NORTHERN

West ½ Section 4, Township 1 North, Range 41 East, MPM

1974: 52.3 ac. winter wheat, average yield-36.4 bu/ac.
48.4 ac. summer fallow

1973: 81.3 ac. winter wheat, average yield-37.2 bu/ac.
78.8 ac. summer fallow

1972: 82.6 ac. winter wheat, crop received heavy hail damage
85.5 ac. summer fallow

Because of a land trade I have no crop information on Section 4 after 1974.

Sincerely yours,

E. E. Heinle

E. E. Heinle
Suprv. Croplands

EEH/ja

APPENDIX B.

Productivity data for community types in area E_2.[1]

Community type	Forage Class	Pounds/acre[2]	Standard Error (±)
212.1	Forbs	102	22
	Shrubs	494	243
	Grass	447	70
212.2	Forbs	14	7
	Shrubs	1,255	582
	Grass	811	398
111.3	Forbs	180	84
	Shrubs	332	149
	Grass	815	71
111.4	Forbs	253	130
	Shurbs	492	60
	Grass	849	181
351	Forbs	141	56
	Shrubs	109	57
	Grass	20	16
211	Forbs	45	40
	Shrubs	717	253
	Grass	603	45

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[1] Data from E.C.S., 1974 (3).

APPENDIX D-3

PLANT SPECIES LIST

Compiled by Sindelar and Plantenberg (6)

Plant species occurring in the study area.

List of plant species observed near Colstrip, Mt.

Scientific Name	Common Name
Acer negundo	Box elder
Achillea millefolium	Common yarrow
Agoseris glauca	Pale agoseris
Agropyron albicans	Montana wheatgrass
Agropyron cristatum	Crested wheatgrass
Agropyron dasystachyum	Thickspike wheatgrass
Agropyron elongatum	Tall wheatgrass
Agropyron riparium	Streambank wheatgrass
Agropyron sibericum	Siberian wheatgrass
Agropyron smithii	Western wheatgrass
Agropyron spicatum	Bluebunch wheatgrass
Agropyron trichophorum	Pubescent wheatgrass
Agropyron trachycaulum	Slender wheatgrass
Allium textile	Prairie onion
Allysum alyssoides	Allysum
Amaranthus albus	Pigweed
Amaranthus graecizans	Prostrate pigweed
Amaranthus retroflexus	Redroot pigweed
Ambrosia psilostachya	Western ragweed
Ambrosia trifida	Giant ragweed
Andropogon gerardi	Big bluestem
Andropogon hallii	Sand bluestem
Andropogon scoparius	Little bluestem
Antennaria spp.	Pussytoes
Antennaria microphylla	Littleleaf pussytoes
Antennaria parviflora	Small-leaf pussytoes
Apocynum spp.	Indian hemp
Arabis holboellii	Holboel rockcress
Arenaria hookeri	Hooker sandwort
Argemone intermedia	Intermediate pricklypoppy
Aristida longiseta	Red threeawn
Arnica sororia	Arnica
Artemisia campestris	Common sagewort
Artemisia cana	Silver sagebrush
Artemisia dracunculus	Falsetarragon sagewort
Artemisia frigida	Fringed sagewort
Artemisia ludoviciana	Prairie sagewort
Artemisia tridentata	Big sagebrush
Asclepias spp.	Milkweed
Asclepias pumila	Plains milkweed
Asclepias speciosa	Showy milkweed
Asclepias viridiflora	Green milkweed
Aster spp.	Aster
Aster campestris	Meadow aster
Astragalus spp.	Milkvetch
Astragalus agrestis	Field milkvetch

List of plant species observed near Colstrip, Mt. (cont.)

Scientific Name	Common Name
Astragalus bisulcatus	Twogroove milkvetch
Astragalus cicer	Cicer milkvetch
Astragalus crassicarpus	Groundplum milkvetch
Astragalus geyeri	Geyer milkvetch
Astragalus gilviflorus	Threeleaved milkvetch
Astragalus missouriensis	Missouri milkvetch
Astragalus purshii	Pursh loco
Atriplex spp.	Saltbush
Atriplex canescens	Fourwing saltbush
Atriplex confertifolia	Shadscale saltbush
Atriplex nuttallii	Nuttall saltbush
Atriplex patula	Fathen saltbush
Avena fatua	Wild oat
Avena sativa	Common oat
Besseya spp.	Kittentails
Boletus spp.	(fungi)
Bouteloua curtipendula	Sideoats grama
Bouteloua gracilis	Blue grama
Brassica kaber	Charlock mustard
Bromus spp.	Brome
Bromus arvensis	Field brome
Bromus inermis	Lincoln brome
Bromus japonicus	Japanese brome
Bromus tectorum	Cheatgrass
Buchloe dactyloides	Common buffalograss
Calamagrostis spp.	Reedgrass
Calamagrostis montanensis	Plains reedgrass
Calamovilfa longifolia	Prairie sandreed
Calochortus nuttallii	Sego mariposalily
Camelina microcarpa	Littlepod falseflax
Campanula rotundifolia	Roundleaf harebell
Carex spp.	Sedge
Carex eleocharis	Needleleaf sedge
Carex filifolia	Threadleaf sedge
Carex pennsylvanica	Penn sedge
Castilleja sessiliflora	Downy paintbrush
Centaurea spp.	Centaurea
Cerastium arvense	Field chickweed
Chenopodium spp.	Goosefoot
Chenopodium album	Lambsquarters goosefoot
Chenopodium botrys	Jerusalem oak
Chenopodium leptophyllum	Narrowleaf goosefoot
Chorispora tenella	Blue mustard
Chrysopsis villosa	Hairy goldaster
Chrysothamnus nauseosus	Rubber rabbitbrush
Chrysothamnus viscidiflorus	Green rabbitbrush
Cichorium intybus	Common chicory
Cirsium arvense	Canada thistle

List of plant species observed near Colstrip, Mt. (cont.)

Scientific Name	Common Name
Cirsium undulatum	Wavyleaf thistle
Cirsium vulgare	Bull thistle
Cleome serrulata	Rockymountain beeplant
Collybia spp.	(fungi)
Comandra umbellata	Bastard toadflax
Convolvulus arvensis	Field bindweed
Coryphantha missouriensis	Yellow pincushion cactus
Crepis spp.	Hawksbeard
Cryptantha celosioides	Miners candle
Dactylis glomerata	Orchard grass
Delphinium bicolor	Low larkspur
Descurainia spp.	Tansymustard
Descurainia pinnata	Pinnate tansymustard
Distichlis stricta	Inland saltgrass
Draba reptans	Draba
Echinacea pallida	Purple coneflower
Echinochloa crusgalli	Common barnyardgrass
Eleagnus angustifolia	Russian olive
Elymus canadensis	Canadian wildrye
Elymus cinereus	Basin wildrye
Erigeron spp.	Fleabane
Erigeron divergens	Spreading fleabane
Erigeron pumilis	Low fleabane
Eriogonum spp.	Wildbuckwheat
Eriogonum annuum	Annual eriogonum
Eriogonum pauciflorum	
Erysimum asperum	Plains wallflower
Euphorbia glyptosperma	Ridgeseed spurge
Euphorbia robusta	Robust spurge
Eurotia lanata	Winterfat
Evolvulus nuttallianus	Nuttall evolvulus
Festuca spp.	Fescue
Festuca arundinacea	Tall fescue
Festuca elatior	Meadow fescue
Festuca occidentalis	Western fescue
Festuca octoflora	Sixweeks fescue
Festuca ovina	Hard fescue
Fritillaria atropurpurea	Leopard lily
Fulgensia fulgens	(lichen)
Gaillardia aristata	Common gaillardia
Gaura coccinea	Scarlet gaura
Gaura parvilflora	Smallflower gaura
Geum triflorum	Prairiesmoke
Gilia congesta	Ballhead gilia
Glycyrrhiza lepidota	Wild licorice

List of plant species observed near Colstrip, Mt. (cont.)

Scientific Name	Common Name
Grindelia squarrosa	Curlycup gumweed
Gutierrezia sarothrae	Broom snakeweed
Happlopappus spinulosus	Spiny goldenweed
Helianthus annuus	Common sunflower
Helianthus petiolaris	Prairie sunflower
Hordeum jubatum	Foxtail barley
Hordeum vulgare	Sixrow barley
Hymenopappus filifolius	Fineleaf hymenopappus
Iva axillaris	Poverty weed
Iva xanthifolia	Marshelder
Juniperus horizontalis	Creeping juniper
Juniperus scopulorum	Rockymountain juniper
Kochia scoparia	Summer cypress
Koeleria cristata	Prairie junegrass
Lactuca pulchella	Blue lettuce
Lactuca serriola	Prickly lettuce
Lathyrus bijugatus	Drybard peavine
Lepidium spp.	Pepperweed
Lepidium densiflorum	Prairie pepperweed
Lesquerella alpina	Alpine bladderpod
Leucocrinum montanum	Common starlily
Liatris punctata	Dotted gayfeather
Linum campanulatum	Harebell flax
Linum perenne	Perennial flax
Linum rigidum	Stiffstem flax
Lithospermum incisum	Narrowleaf gromwell
Lomatium spp.	Biscuitroot
Lupinus spp.	Lupine
Lygodesmia juncea	Rush skeletonplant
Medicago sativa	Alfalfa
Melilotus alba	White sweetclover
Melilotus officinalis	Yellow sweetclover
Mentzelia decapetala	Tenpetal blazingstar
Microseris cuspidata	Toothed microseris
Muhlenbergia cuspidata	Plains muhly
Musineon divaricatum	Wild parsely
Noctac spp.	(algae)
Oenothera spp.	Eveningprimrose
Oenothera albicaulis	Prairie eveningprimrose
Oenothera nuttallii	Nuttall eveningprimrose
Oenothera serrulata	Shubby eveningprimrose
Onobrychis viciaefolia	Sainfoin
Opuntia fragilis	Brittle pricklypear
Opuntia polyacantha	Plains pricklypear

List of plant species observed near Colstrip, Mt. (cont.)

Scientific Name	Common Name
Orthocarpus luteus	Yellow owlclover
Oryzopsis hymenoides	Indian ricegrass
Oxytropis spp.	Loco
Oxytropis besseyi	Bessey loco
Oxytropis sericea	Whitepoint loco
Panicum virgatum	Switchgrass
Parmelia chlorochroa	(lichen)
Penstemon spp.	Penstemon
Penstemon albidus	White penstemon
Petalostemon candidum	White prairieclover
Petalostemon oligophyllum	Slender white prairieclover
Petalostemon purpureum	Purple prairieclover
Phacelia linearis	Threadleaf phacelia
Phleum pratense	Common timothy
Phlox spp.	Phlox
Phlox alyssifolia	Allysum-leaved phlox
Phlox hoodii	Hoods phlox
Physalis longifolia	Longleaf groundcherry
Pinus ponderosa	Ponderosa pine
Plantago patagonica	Woolly plantain
Poa spp.	Bluegrass
Poa juncifolia	Alkali bluegrass
Poa pratensis	Kentucky bluegrass
Poa sandbergii	Sandberg bluegrass
Polemonium spp.	Polemonium
Pollybastia obsoleta	(lichen)
Polygala alba	White polygala
Polygonum spp.	Knotweed
Polygonum douglasii	Douglas knotweed
Populus spp.	Cottonwood
Populus angustifolia	Narrowleaf cottonwood
Populus deltoides	Eastern cottonwood
Potentilla spp.	Cinquefoil
Potentilla glandulosa	Gland cinquefoil
Prunus americana	American plum
Prunus virginiana	Chokecherry
Psoralea argophylla	Silverleaf scurfpea
Psoralea esculenta	Common breadroot scurfpea
Psoralea tenuifolia	Slimflower scurfpea
Puccinellia airoides	Nuttall alkaligrass
Purshia tridentata	Bitterbrush
Ratibida columnifera	Prairie coneflower
Rhus radicans	Poison ivy
Rhus trilobata	Skunkbrush sumac

List of plant species observed near Colstrip, Mt. (cont.)

Scientific Name	Common Name
Ribes aureum	Golden currant
Ribes cereum	Squaw currant
Ribes setosum	Redshoot gooseberry
Rosa arkansana	Prairie rose
Rosa woodsii	Woods rose
Rumex crispus	Curly dock
Salsola kali	Russian thistle
Sarcobatus vermiculatus	Greasewood
Schedonnardus paniculatus	Tumblegrass
Secale cereale	Common rye
Senecio spp.	Groundsel
Senecio canus	Woolly groundsel
Senecio plattensis	Prairie groundsel
Seteria spp.	Bristlegrass
Shepherdia argentea	Buffaloberry
Silene cserei	Smooth catchfly
Sisymbrium altissimum	Tumbling mustard
Sisymbrium loeselii	Tall hedgemustard
Sisyrinchium spp.	Blueeyedgrass
Sitanion hystrix	Bottlebrush squirreltail
Solanum triflorum	Cutleaf nightshade
Solidago spp.	Goldenrod
Solidago canadensis	Canada goldenrod
Solidago missouriensis	Missouri goldenrod
Solidago mollis	Velvety goldenrod
Solidago rigida	Stiff goldenrod
Sorghum sudanense	Sudangrass sorgho
Sphaeralcea coccinea	Scarlet globemallow
Sporobolus airoides	Alkali dropseed
Sporpbolus cryptandrus	Sand dropseed
Stelleria media	Chickweed
Stephanomeria runcinata	Desert wirelettuce
Stipa comata	Needle and thread grass
Stipa viridula	Green needlegrass
Symphoricarpos albus	Common snowberry
Symphoricarpos occidentalis	Western snowberry
Taraxacum officinale	Common dandelion
Tetradymia canescens	Gray horsebrush
Thelasperma marginatum	Greenthread
Thermopsis rhombifolia	Goldenpea
Thlaspi arvense	Field pennycress
Tortula spp.	(moss)
Townsendia exscapa	Stemless townsendia
Tradescantia bracteata	Bracted spiderwort
Tragopogon dubius	Yellow salsify

List of plant species observed near Colstrip, Mt. (cont.)

Scientific Name	Common Name
Tribulus terrestris	Puncturevine feverplant
Trifolium spp.	Clover
Triticum aestivum	Bread wheat
Tulostoma spp.	(fungi)
Typha latifolia	Common cattail
Vaccaria segetalis	Cowcockle
Verbascum thapsus	Flannel mullein
Vicia spp.	Vetch
Vicia americana	American vetch
Viola nuttallii	Nuttall violet
Xanthium spp.	Cocklebur
Yucca glauca	Small soapweed
Zygadenus venenosus	Meadow deathcamus

APPENDIX E.

Species of wildlife in the region. [1]

	Scientific Name	Common Name
MAMMALS:	Antilocapra americana	Pronghorn antelope
	Canis latrans	Coyote
	Cynomys ludovicianus	Black-tailed prairie dog
	Erethizon dorsatum	Porcupine
	Eutamias minimus	Least chipmunk
	Lepus townsendii	White-tailed jackrabbit
	Lynx rufus	Bobcat
	Marmota flaviventris	Yellow-bellied marmot
	Mephitis mephitis	Striped skunk
	Microtus ochrogaster	Prairie vole
	Mus musculus	House mouse
	Mustela frenata	Longtail weasel
	Myotis lucifugus	Little brown bat
	Odocoileus hemionus	Mule deer
	Odocoileus virginianus	White-tailed deer
	Ondatra zibethicus	Muskrat
	Onychomys leucogaster	Grasshopper mouse
	Perognathus fasciatus	Olive-backed pocket mouse
	Peromyscus maniculatus	Western deer mouse
	Procyon lotor	Racoon
	Reithrodontomys megalotis	Harvest mouse
	Sorex cinereus	Masked shrew
	Spermophilus tridecemlineatus	Thirteen-lined ground squirrel
	Sylvilagus audubonnii	Desert cottontail
	Taxidea taxus	Badger
	Thomomys talpoides	Northern pocket gopher
	Vulpes vulpes	Red fox
BIRDS:	Actitis macularia	Spotted sandpiper
	Aeronautes saxatalis	White-throated swift
	Agelaius phoeniceus	Red-winged blackbird
	Ammodramus savannarum	Grasshopper sparrow
	Anas acuta	Pintail
	Anas cyanoptera	Cinnamon teal
	Anas discors	Blue-winged teal
	Anas platyrhynchos	Mallard
	Anas strepera	Gadwall
	Aquila chrysaetos	Golden eagle
	Ardea herodias	Great blue heron
	Asio flammeus	Short-eared owl
	Bartramia longicauda	Upland plover
	Branta cananadensis	Canada goose
	Bubo virginianus	Great horned owl
	Buteo jamaicensis	Red-tailed hawk

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[1] Data from Ecological Consulting Service (10) and Lewis, Morton and Jones (13).

APPENDIX D-4

SPECIES OF WILDLIFE IN THE REGION

Species of wildlife in the region. (continued)

	Scientific Name	Common Name
BIRDS:	Calamospiza melanocorys	Lark bunting
	Capella gallinago	Common snipe
	Centrocercus urophasianus	Sage grouse
	Charadrius vociferus	Killdeer
	Chondestes grammacus	Lark sparrow
	Chordeiles minor	Common night hawk
	Circus cyaneus	Marsh hawk
	Coccyzus americanus	Yellow-billed cuckoo
	Colaptes cafer	Red-shafted flicker
	Contopus sordidulus	Western wood pewee
	Corvus brachyrhynchos	Common crow
	Dendroica auduboni	Audubon warbler
	Dendroica petechia	Yellow warbler
	Dumetella carolinensis	Catbird
	Empidonax oberholseri	Dusky flycatcher
	Eremophila alpestris	Horned lark
	Euphagus carolinus	Rusty blackbird
	Euphagus cyanocephalus	Brewer's blackbird
	Falco sparverius	Sparrow hawk
	Falco mexicanus	Prairie falcon
	Fulica americana	American coot
	Geothlypis trichas	Yellowthroat
	Gymnorhinus cyanocephala	Pinyon jay
	Haliaeetus leucocephalus	Bald eagle
	Hirundo rustica	Barn swallow
	Icteria virens	Yellow-breasted chat
	Icterus bullockii	Bullock's oriole
	Lanius ludovicianus	Loggerhead shrike
	Loxia curvirostra	Red crossbill
	Mareca americana	American widgeon
	Melanerpes erythrocephalus	Red-headed woodpecker
	Melospiza melodia	Song sparrow
	Molothrus ater	Brown-headed cowbird
	Parus atricapillus	Black-capped chickadee
	Passer domesticus	House sparrow
	Pedioecetes phasianellus	Sharp-tailed grouse
	Perdix perdix	Hungarian partridge
	Petrochelidon pyrrhonota	Cliff swallow
	Phasianus colchicus	Ring-necked pheasant
	Pheucticus melanocephalus	Blackheaded grossbeak
	Pica pica	Magpie
	Pipilo erythrophthalmus	Rufous-sided towhee
	Pooecetes gramineus	Vesper sparrow
	Quiscalus quiscula	Common grackle
	Rhynchophanes mccownii	McCown's longspur
	Riparia riparia	Bank swallow

Species of wildlife in the region. (continued)

	Scientific Name	Common Name
BIRDS:	Salpinctes obsoletus	Rock wren
	Syarnis saya	Say's phoebe
	Setophaga ruticilla	American redstart
	Sialia currucoides	Mountain bluebird
	Sitta carolinensis	White-breasted nuthatch
	Spatula clypeata	Shoveller
	Spinus tristis	American goldfinch
	Spizella breweri	Brewer's sparrow
	Spizella pallida	Clay-colored sparrow
	Steganopus tricolor	Wilson's phalarope
	Stelgidopteryx ruficollis	Rough-winged swallow
	Sturnella neglecta	Western meadowlark
	Sturnus vulgaris	Starling
	Tachycineta thalassina	Violet-green swallow
	Toxostoma rufum	Brown thrasher
	Troglodytes aedon	House wren
	Turdus migratorius	Robin
	Tyrannus tyrannus	Eastern kingbird
	Tyrannus verticalis	Western kingbird
	Vireo olivaceus	Red-eyed vireo
	Zenaidura macroura	Mourning dove
	Zonotrichia leucophrys	White-crowned sparrow
REPTILES:	Chelyara serpentina	Common snapping turtle
	Chrysemys picta	Western painted turtle
	Coluber constrictor	Racer
	Crotalus viridis	Prairie rattlesnake
	Heterodon nasicus	Hognose snake
	Pituophis catenifer	Bull snake
	Scelopamus graciosus	Sagebrush lizard
AMPHIBIANS:	Rana pipiens	Leopard frog

APPENDIX D-5

DESCRIPTION OF AREA E GRADED SPOILS RESEARCH AREA
BY DR. BRIAN SINDELAR, M.S.U.

Montana State University

College of Agriculture

Agricultural Experiment Station
Bozeman, Montana 59715 Tel. 406-994-3721

Animal and Range Sciences Department

March 11, 1977

Dr. Dana Schmidt
Olson-Elliott & Associates
P. O. Box 1209
Helena, MT 59601

Dear Dr. Schmidt:

In response to your recent inquiry concerning my ERDA-sponsored research in Area E near Colstrip, I am providing you with more detailed information. You should soon receive a copy of the annual progress report which explains the study in depth.

Five of our 13 study sites consist of overburden material placed on rangeland in flattened mounds in 1924. To my knowledge these sites represent the oldest leveled mine spoils in southeastern Montana. I specificially mention "leveled" in that unleveled spoils are characteristically unstable and are normally incapable of sustaining typical continuous vegetational progression. This is due to their steepness and consequent precipitation runoff, surface erosion, and their slope orientation. Leveled spoils more accurately reflect the kind and rate of plant succession that might be expected on mined lands undergoing reclamation. I am not aware of any other leveled coal spoils of this age in Montana. This is one of the most important values of the "1924" sites.

Another major value of the 1924 sites is that, although over 50 years old, several of the sites remain in low seral stages. They are still dominated by cheatgrass and false-tarragon sagewort, both considered undesirable range weeds. This is in sharp contrast to younger (1932) leveled spoils that have progressed to relatively high seral stages. It is of considerable importance to determine the bases for the very slow rate of succession on the 1924 sites in order to assure that similar conditions are not recreated by current mining practices. There is a unique opportunity to discover the reason(s) for this phenomenon through detailed study of the five 1924 sites. Some of the five sites are more advanced successionally than the others. In fact the five sites, which are located along a mile-long north-south axis, appear to represent a series of successional stages. Each site, beginning with the southernmost (1924-1), is somewhat more successionally advanced. The northernmost site (1924-6) has perennial grasses and forbs and is similar to poor condition native rangeland. The five 1924 sites are on similar overburden materials with no apparent chemical or physical differences.

Because of the unique and important ecological nature of the 1924 sites, ERDA has funded two graduate research studies which deal specifically with them. These studies are in addition to the overall research effort I'm conducting on mined land plant succession. Each graduate student began studies on the sites in April 1976, and collected basic data through the 1976 growing season. To fully implement their individual research plans they must collect additional data of a different nature through the 1977 growing season. With these data, mysteries of the 1924 sites should be revealed. This would surely provide a better understanding of successional changes presently occurring on recently mined and revegetated lands in eastern Montana.

Other scientists have recognized the value of the 1924 sites and initiated studies on them in spring 1976. The Cooperative States Research Service funded a Montana Agricultural Experiment Station study, "The Effect of Time on Root Characteristics, Soil Genesis, and Hydrologic Properties of Strip Mine Spoils," which utilizes three of the 1924 spoil mounds. Dr. Nielsen, Dr. Dollhopf, and Mr. Schafer of MSU are conducting the study. In addition, a graduate thesis project is associated with the study. This research is scheduled to continue into the 1977 growing season.

After reporting the ERDA research at Argonne National Laboratory's Land Reclamation Program in Chicago recently, several reclamation researchers indicated plans to visit the sites. These scientists include: Dr. James Carel, University of Missouri; Dr. Becky Green, Argonne National Lab; and Dr. Mike Miller, Argonne National Lab. Dr. Ralph Carter, Director of the Land Reclamation Program also expressed his interest in the project.

Considerable expense and effort has been invested in the 1924 sites to date. ERDA funding through this year will total $125,000. Without the detailed work planned for the 1977 growing season, much of the value of the 1924 sites would be lost.

I should add that only two years of data collection were anticipated on the 1924 sites because Western Energy Company indicated its plans to mine the area. At the time we initiated the research I understood that two growing seasons would be available for study. I was distressed to hear that the sites may be destroyed this spring. Such an occurrence would certainly reduce the value of work conducted on the sites to date, and would essentially prevent determination of the reason why these sites remain in lower stages of successional development.

It is my opinion that the 1924 sites should not be mined or disturbed in any way prior to collection of critical vegetational data in the 1977 growing season. While every effort can and will be made to retrieve all data from the sites as soon as physically possible, certain sampling dates are determined by nature itself. Peak vegetational biomass in the Colstrip area normally occurs at about the end of July or beginning of August. This is one of the most critical measures and along with plant cover is a basis for our successional analyses. And should this be a year of drought, these data become even more critical.

I also believe that two complete years of detailed documentation such as indicated in our annual report will provide an acceptable preservation of the 1924 sites following their destruction by mining. A single year will not. Obviously, additional studies on the 1924 sites could be continued for years if it was not necessary to mine them. However, academic value beyond that provided by the current two-year study can be satisfied to a great extent by our 1932 site (Cape Oliver).

I hope that this discussion will be of value to you in your work. Please contact me if I can be of further service.

Sincerely,

Brian Sindelar

Brian W. Sindelar
Research Associate

BWS/mfs

APPENDIX E-1

YELLOWSTONE RIVER SUBBASIN USE

APPENDIX E-1

Current land use in Rosebud County is shown in Table 30; similar use categories for the Northern Cheyenne Reservation are shown in Table 31. Land use makeup for the Yellowstone River subbasin as of 1972 on a percentage breakdown. Because of the various sources and differing categories used by the compilers of this data, no attempt will be made here to correlate the findings of each table in a uniform manner.

YELLOWSTONE RIVER SUBBASIN LAND USE, 1972

USE	Breakdown 1,000 Acres	%
Pasture and Range	33,628	74
Forest and Woodland	6,100	14
Cropland	3,400	8
Recreation	1,400	3
Urban and Transportation	200	-
Fish and Wildlife	50	-
Mineral Industry	10	-
Military	10	-
Other Agriculture	100	-
Water	300	-
TOTAL	45,198	

Source: Proposed Federal Coal Leasing Program, Draft Environmental Impact Statement, Volume 1, U.S. Department of the Interior, Bureau of Land Management, 1974; p. 11-174.

APPENDIX E-2

SECTOR EMPLOYMENT AND SECTOR INCOME PER EMPLOYEE

APPENDIX E-2

A picture of the structure of the Rosebud County economy can be obtained by looking at the distribution of employment between sectors shown in table 1. The agricultural sector's share of the total fell from 27 percent to 20 percent as its employment remained relatively constant and the rest of the sectors added workers. Mining and construction now account for 13 percent, while trade and services have almost 20 percent of the total. This compares to corresponding percentages of 3 and 24, respectively, in 1974.

Average annual income per employee was calculated by dividing each sector's income by its employment; the results are listed in table 2. This gives some notion of the wide income variations among sectors and indciates how these have changed since 1970. As a result of the power plant construction at Colstrip, the highest paid sector and the one with the greatest change is the construction sector with income of $15,905 per employee per year. Despite the high wages in this sector, the average nonagricultural income in Rosebud County remains below the state average. The county average, except in 1974, emphasizes the continued importance of this sector to the Rosebud economy.

Reconciliation of the census and the BEA income series is more difficult than for employment. Total income from the census was $13,928,000 for 1969, and the 1969 total personal income figure from BEA was $17,772,000. Once again, the discrepancy is due to definitional differences between the two series. The BEA income series includes such income as "in kind" income, income of non-profit organizations, income essential from the value of bank services and the services of other financial firms rendered to persons without charge, and Medicare payments. These items are not included by the census. Moreover, the census data are obtained directly from households, while the BEA series is estimated largely on the basis of data from the administration records of business and governmental sources. Since reconciliation is not critical for the impact assessment process, no adjustments were attempted.

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1. Although there are sources of potential error in the estimation method it is the best, consistent method available.

2. This is generally referred to as hidden unemployment.

3. Welfare, religious, and nonprofit organizations includes such things as the St. Labre School, tribal employment, churches and various social service groups.

4. Median family income is that income level for which there is an equal number of families above and below.

TABLE 1

DISTRIBUTION OF EMPLOYMENT IN ROSEBUD COUNTY, 1970-1974
(GIVEN AS PERCENTAGE OF TOTAL EMPLOYMENT)

Sector	1970	1971	1972	1973	1974
Agriculture[a]	27.4	25.6	23.8	21.5	20.3
Mining	1.6	2.8	3.5	8.1	8.1
Construction	1.1	.9	1.3	2.3	5.1
Manufacturing	8.4	8.2	8.9	5.8	5.1
Transportation, Communication, Public Utilities	7.2	6.5	6.3	5.8	5.8
Trade	8.5	8.7	9.0	10.1	9.8
Finance, Insurance, Real Estate	.7	.9	1.2	1.3	1.5
Services	15.5	18.4	18.9	19.7	19.1
Government	18.4	16.5	15.9	15.0	15.5
Other[a]	12.1	11.5	11.2	10.2	9.5
TOTAL	100.0	100.0	100.0	100.0	100.0

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[a] Includes self-employed proprietors.

Source: Derived.

TABLE 2

INCOME PER EMPLOYEE, ROSEBUD COUNTY, 1970-1974
(CURRENT DOLLARS)

Sector	1970	1971	1972	1973	1974
Agriculture	8272	8454	11244	17097	5182
Mining	13214	10215	10718	13609	13738
Construction	8000	5160	7743	10394	15738
Manufacturing	4389	4812	4265	4801	5605
Transportation, Communication, Public Utilities	8554	9110	9770	10931	10961
Trade	3310	3409	3476	3590	4951
Finance, Insurance, Real Estate	4631	5077	5216	5595	7038
Services	3896	3728	4176	4094	4923
Government	5613	6136	6525	7083	7511
Other	4042	3428	3581	3766	4214
Rosebud Total	5944	5954	6750	8630	7007
Rosebud Non-Ag Total	5066	5095	5344	6316	7473
Montana Total	6378	6432	7359	8325	NA
Montana Non-Ag Total	6093	7617	6743	7124	NA
Rosebud/Montana					
Total	.93	.92	.92	1.04	NA
Non-Agriculture	.83	.76	.79	.89	NA

Source: Derived.

APPENDIX E-3

DETAILED DESCRIPTION OF ROSEBUD COUNTY'S SCHOOL DISTRICTS

APPENDIX E-3

Nine school districts are located within Rosebud County. Enrollment varies from 12 to 685 and those districts most impacted by the growth of Colstrip are undergoing construction, and/or other improvements. A brief description of each follows:

District #2

District #2 in Angela includes Grades 1 through 6 and has a student enrollment of six with one teacher. The school building is in good condition and can accommodate 12 to 15 students. Busing mileage within the district is 16 miles.

District #33

The Ingamar District #33 has a 1976-1977 student enrollment of 25 in grades 1 through 8 and employs four teacher and staff members. Speech therapy and special education are available. The building is considered adequate and can accommodate 32 students.

District #3

District #3 in Birney has a student enrollment of 12 in grades 1 through 12, and has two teachers; however, next year there will be only one. The school building is in good condition and can accommodate 26 students.

District #6

Lame Deer, District #6, offers a K-8 grade curriculum with an enrollment of 415 students. Teachers and staff number 24. The school is considered in good condition.

District #32J

Enrollment for the 1976-1977 school term was 92 students, with ten staff members. The building program of the Ashland district will double the present facility, adding approximately 20,000 square feet and a gym with a seating capacity of 300. The entire project is expected to take 8 to 12 months to complete once construction is begun this summer. The new facility will also be available for various community activities.

District #12

District #12, in Rosebud, includes grades K-12, with a present student population of 168. The school is housed in one building with the elementary school wing (gr. 1-6) and the high school wing (gr. 7-12) separated by the lunchroom. The school is in excellent condition; the elementary school is at capacity, and the high school could absorb approximately 15 more students. There are 15 teachers and other staff in the district. Construction to add elementary rooms and a music room was begun in December, 1976. Completion will be in Septebmer, 1977.

District #4

Forsyth, at present, is the largest district in Rsoebud County with a total enrollment of 685 students; the elementary school has 349 students, the middle school, 105 students, and the high school, 231 students. There are 47 teachers, 4 administrators, and 22 noncertified staff members within the district. Construction of two new buildings is expected to commence this summer with completion within 12 to 16 months. One building will accommodate grades K-5 and the other will house grades 6-8. Together these will double the capacity of the elementary school.

District #19

School District #19 in Colstrip also has a building program. A bond issue for $2,893,730 has been passed for the construction of an elementary school, the remodeling of the high school, with addition for a shop, girl's locker room, weight and wresting room, and food service receiving and storage. Construction is expected to begin in early summer of 1977, with a completion date of January, 1978. The building program will give the district an elementary school capacity of 400 and high school capacity of 300. Future growth for the district has been provided for in the event Colstrip Generating Units 3 and 4 are constructed.

At present the district is housed in two buildings with 310 elementary students and 387 junior and senior high students, and 43 teachers and staff.

APPENDIX E-4

Table 1 Highway Status - Rosebud County

Table 2 Average Daily Traffic Counts

TABLE 1

HIGHWAY STATUS: ROSEBUD COUNTY

Route Designation	Surface Type[1]	1975 Average Daily Traffic (ADT)[2]	Planned Improvements and/or Changes[3]	1990 Functional Classification[4]
INTERSTATE HIGHWAYS				
I-94 (US10, 312)	2,4 Lane Paved	3340[5]--entering from west 3160[5]--entering from east	Widen to 4-Lane: Forsyth area 10 miles, anticipated completion, 1980; Hysham area 21.6 miles, anticipated completion July, 1977; Hathaway area 5.6 miles, anticipated completion 1979; funds through Interstate Programs	Interstate system
PRIMARY HIGHWAYS				
US 12 (FAP 14)	2 - lane Paved	243 Mussellshell & Rosebud Co. lines 245 Sumatra 223 Ingomar 253 Vananda 759[6] entering Forsyth		Minor arterial
FAP 2	2 - lane Paved	109 M.P. 551 562 M.P. 560 132 M.P. 571 283 M.P. 577 241 M.P. 578 128 M.P. 580		Major collector

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1. General Highway Maps, Rosebud County, Montana prepared by Montana State Highway Commission, Planning Survey section, December, 1961, revised December 31, 1973.
2. Average Daily Traffic Counts, Department of Highways, State of Montana.
3. Les Harris, Planning and Research Bureau, Montana State Highway Commission, Helena, Montana: Communication March 17, 1977.
4. State of Montana 1990 Highway Functional Classification, January, 1971, revised June 1, 1974.
5. 1976 survey
6. 1974 survey

TABLE 1 (continued)

Route Designation	Surface Type	1975 Average Daily Traffic (ADT)	Planned Improvements and/or Changes	1990 Functional Classification
OTHER HIGHWAYS				
SECONDARY HIGHWAYS				
FAS 315	2 - lane Paved	1243[5]--I-94 to 315 (1975 data) 1055[5]--12 miles south of I-94 964[5]--7 miles north of Colstrip 1779[5]--Just north of Colstrip 1133[5]--Just south of Colstrip junction 328[5]--13 miles north of Lame Deer 807[5]--Just north of Lame Deer	Upgrade road to meet secondary road standards--from I-94 south to Lame Deer, total of 52 miles. Proposed first priority for coal impact funds--work to be done by 1980.	Minor arterial to south of 212 where it becomes a minor collector
FAS 447	2 - lane Paved from I-94 south for 8 miles then gravel graded and drained	248 M.P. 0.0 (Junct. FAP 2) 176 M.P. .079 5 M.P. 3 81 M.P. 32 220 M.P. 53	Upgrade road to secondary road standards from I-94 south to Ashland, a total of approximately 55 miles. Proposed for improvement with coal impact funds, work to be done by 1980. Also scheduled for improvements with economic growth funds for 80 miles of grading and graveling in 1978--improvements proposed under coal impact plans will probably take precedence.	Major collector
FAS 446	2 - lane Paved from Rosebud for 10 miles east	249 Junct. FAP 2 at Rosebud 131 Cartersville		Minor collector

TABLE 1 (continued)

Route Designation	Surface Type	1975 Average Daily Traffic (ADT)	Planned Improvements and/or Changes	1990 Functional Classification
UNDESIGNATED MAJOR ROADS				
Road north of Yellowstone River from Forsyth to Rosebud	2 - lane Gravel graded and drained			Major collector
Road from FA311 at Alkalai Creek to Sumatra	2 - lane Gravel graded and drained for 3 miles north then dirt graded and drained to county line then gravel to Sumatra		County has made request for systems funding for 19 miles of graveling	Minor collector

TABLE 1 (continued)

Route Designation	Surface Type	1975 Average Daily Traffic (ADT)	Planned Improvements and/or Changes	1990 Functional Classification
East-west road from Sarpy Creek Road to Colstrip intersecting Sarpy Creek Road near Horse Creek	2 - lane Gravel graded and drained	278[6]--1 mile west of Colstrip		Minor collector
Road along Great Porcupine Creek north of FAP 14	2 - lane Gravel graded and drained			Minor collector
Road north of Forsyth crossing Little Porcupine Creek	2 - lane Gravel graded and drained for 11 miles north then dirt graded drained			Minor collector

TABLE 1 (continued)

Route Designation	Surface Type	1975 Average Daily Traffic (ADT)	Planned Improvements and/or Changes	1990 Functional Classification
Road along Rosebud Creek between FAS 447 and FAS 315	2 - lane Gravel graded and drained			Minor collector
Road from 314 north of Decker to Birney	2 - lane Gravel graded and drained		Upgraded to secondary road standards from 314 to Birney approximately 25 miles; Proposed for coal impact funds, unscheduled date.	Major collector
Road from Decker northeast towards Otter	2 - lane Gravel graded and drained			Minor collector

TABLE 2

AVERAGE DAILY TRAFFIC COUNTS (ADT's)

		ADT's										
YEAR		1963	1965	1967	1969	1970	1971	1972	1973	1974	1975	1976
Sheet 5*	Sta 16**	1150	1253	1308	193	157	145		780	145	160	158
	Sta 20	1219	1276	1360	294	189	180	163	232	255	260	185
	Sta 21	1322	1470	1479	268	346	300	277	362	400	393	468
	Sta 26	1564	1543	1589	1859	2289	2371	2548	3086	3095	3400	3343
	Sta 27	1622	1778	1812	2319	2517	2605	2630	2993	2917	3221	3159
	Sta 34									985	731	
Sheet 6	Sta 10	1289	1350	1454	1904	2019	54	81	42	91	130	167
	Sta 14	83	68	70	90	110	100	102	115	95	92	86
	Sta 15	1241	1300	1458	1763	2148	170	280	428	313	380	316
	Sta 30						33	46	77	75	128	
Sheet 7	Sta 2	106	104	109	191	289	242	385	994	810	940	1050
	Sta 12	51	47	36	38	34	33	29	40	30	40	37
	Sta 19	135	119	120	199	230	327	610	1357	1282	1759	1507
	Sta 21	96	121	130	169	150	140	367	682	544	573	752
	Sta 30	30	37	31	54	50	39	25	26	29	40	48
Sheet 8	Sta 3	104	119	118	140	181	109	215	332	328	340	378
	Sta 7	64	65	52	85	80	79	61	54	60	90	82
	Sta 11	242	240	271	349	431	508	553	726	717	1080	807
	Sta 12	624	668	762	950	904	942	1067	1094	927	1232	1134
	Sta 13	607	654	797	850	896	830	974	998	1058	1338	1263
	Sta 14					253	306	283	277	423	356	431
	Sta 19	596	551	604	720	692	688	690	707	789	890	758
	Sta 21					174	165	210	199	220	220	375
	Sta 26	56	72	50	72	60	73	96	121	99	60	175
	Sta 39	565	554	599	736	734	759	754	773	850	950	1107
Sheet 9	Sta 11									87	107	
	Sta 18									60	33	
	Sta 24									66	58	

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* Refers to portion of Montana Highway Department Map of Rosebud County
** Stations are identified as follows:

Sheet 5
16 - 4 miles east from Treasure/Rosebud County line on Highway 312/10
20 - ½ mile west of Highway 312 and 315 Junction
21 - 1 mile east of Highway 312 and 315 Junction
34 - 4 miles east of Highway 315 on Highway 312/10
26 - ½ miles west of Forsyth on Highway 312/10
27 - ½ mile east of Forsyth on Highway 312/10

Sheet 6
10 - 6 miles east of Forsyth on Highway 312/10
14 - 4 miles south on FAS 447
15 - ¼ mile west of Rosebud on Highway 312/10
30 - 1½ miles east of Rosebud on Highway 312/10

Sheet 7

2 - 15 miles north of Colstrip on FAS 315
12 - 18 miles north of Junction 315 on FAS 447
19 - 1 mile north of Colstrip on FAS 315
30 - ½ mile south of Junction FAS 447 and Rosebud Creek Road
21 - 1 mile south of Colstrip on FAS 315

Sheet 8

3 - 11 miles north of Lame Deer on FAS 315
7 - 8 miles north of Ashland on gravel road
11 - ½ mile north of Lame Deer on FAS 315
12 - ½ mile east of Lame Deer on 212
13 - ½ mile west of Lame Deer on 212
14 - ½ mile south of Lame Deer on FAS 315
19 - 8 miles east of Lame Deer on 212
21 - 1 mile north of Ashland on gravel road
26 - ½ mile south of Highway 212 on road to Birney
39 - 1 mile west of AShland on Highway 212

Sheet 9

11 - 1 mile north of Birney on gravel road
18 - 7 miles southwest of Birney on gravel road
24 - 1 mile southwest of Birney on gravel road

APPENDIX E-5

CORRESPONDENCE CONCERNING THE SURGE POND RECREATION AREA

STATE OF MONTANA

DEPARTMENT OF

FISH AND GAME

P.O. Box 430
Miles City, MT. 59301
August 5, 1976

Martin White
Western Energy Co.
Colstrip, MT. 59323

Dear Martin:

We sampled the fish population in the Surge Pond with a 50-foot bag seine on August 3 and were pleased with what we found.

Our efforts were concentrated along the southeast shore-line in 2-4 foot deep water. Bottom materials ranged from gravel and sand to mud. In nine seine hauls, we took a total of 23 small fish. The northern pike have shown tremendous growth since they were stocked in June. The nine northerns we took averaged 220 mm (8.7 inches) in length. A catch rate of 1 northern per net haul is a good indication of a fairly high survival rate for these fish. The crappie were successful in getting off a spawn because we did pick up some young-of-the-year (both black and white crappie). These too showed good growth averaging about 70 mm (2.8 inches) in length. Young crappie from the Tongue River Reservoir are only about 40 mm (1.6 inches) in length right now. I'm sure the northerns were able to utilize the small crappie as a food base. However, the crappie have now reached a size which will be difficult for the northerns to utilize. Therefore, I'm going to try to obtain some fathead minnows to transplant into the pond. They will serve as food for northerns, bass and crappie. The bass did survive the plant and are still pretty small. The northerns are probably taking their share of them too.

Aquatic vegetation has got a good start and should provide some excellent habitat for small fish and invertebrates. We were surprised to not find any river-type fish. If anything is coming through the pump, they are being chewed up. This will help to maintain a pure population. We did come up with an immature tiger salamander, however.

Since the northerns appear to have survived the plant and will probably become well established in the reservoir, I'd like to suggest some possible water management alternatives to enhance northern pike production Northerns spawn in the spring, soon after the ice goes off. They move into shallow water and lay their eggs on flooded vegetation. Incubation takes about 10-15 days and the fry remain attached to the vegetation for several days after hatching. The vegetation remains important as escape cover until mid-summer when the northerns begin foraging on other fish and move into deeper water.

Ideally then, water levels should be high enough in the spring to cover the vegetation and remain somewhat stable, at least during the incubation period. As the young fish move into deeper water (mid-June) water levels could be dropped a foot or two which then allows revegetation in the shallow spawning.areas. Thus the critical water level period for the northerns is April-June. The Department understands the need-use concept involved with the surge pond water, but recommends that unnecessary use of this water during this period be minimized. I think by planning maintenance around this period we should be able to produce some pretty fantastic northern pike fishing in this lake.

Thanks for the opportunity to sample the pond and for allowing us to suggest possible water level management schemes. If you have any questions please call.

Best regards,

Allen A. Elser
Regional Fisheries Manager

AAE:fr

cc: Carl Anderson
Art Whitney
Jim Posewitz

APPENDIX E-6

EVALUATION OF LANDSCAPES WITHIN A ONE-DAY TRAVELING DISTANCE

APPENDIX E-6

Evaluation of Landscapes Within a One-Day Traveling Distance:

The objective of this discussion is to provide a perspective on the scenic quality and the value of Areas A and E as they relate to other major types of landscapes within a one-day traveling zone from the study site. A one-day travel zone extends as far west as the Beartooth Mountains, northwest to the Lake Mason National Wildlife Refuge, northeast to Miles City, and south to the Bighorn Mountains. Within this radius there is a wide variety of scenery ranging from flat, open agricultural fields, eroded badlands, dissected plateaus, to dramatic alpine mountains and streams.

A vast band of deeply dissected plateaus and valleys created by numerous drainages and creeks extends in a northwest to southeast direction from the Bull Mountains to Wyoming except for a relatively narrow area of flatter terrain between the Bull Mountains and the Yellowstone River.

Although a similar physiographic character persists throughout this expansive area, there are notable scenic variations due primarily to elevation and vegetation differences. Areas of greater elevation range generally have more abrupt and better defined physiographic features than are found in the Colstrip area. The most visible features of these areas are the Bull Mountains (elevations range 3,100 to 4,700 feet), the Rosebud Mountains (3,700 to 5,200 feet), the Wolf Mountains (3,300 to 4,700 feet), the Little Wolf Mountains (3,400 to 4,800 feet) and the Spray Mountains (3,300 to 4,500 feet). These landforms are characterized by steep terrain, exposed rock areas and well defined canyons and valleys. Locationally, all of these landforms are east and southeast of the Colstrip area, except for the Bull Mountains which are to the northwest.

APPENDIX E-6

Evaluation of Landscapes Within a One-Day Traveling Distance:

The objective of this discussion is to provide a perspective on the scenic quality and value of Areas A and E as they relate to other major types of landscapes within a one-day traveling zone from the study site. A one-day travel zone extends as far west as the Beartooth Mountains, northwest to the Lake Mason National Wildlife Refuge, northeast to Miles City, and south to the Bighorn Mountains. Within this radius there is a wide variety of scenery ranging from flat, open agricultural fields, eroded badlands, dissected plateaus, to dramatic alpine mountains and streams.

A vast band of deeply dissected plateaus and valleys created by numerous drainages and creeks extends in a northwest to southeast direction from the Bull Mountains to Wyoming except for a relatively narrow area of flatter terrain between the Bull Mountains and the Yellowstone River.

Although a similar physiographic character persists thoughout this expansive area, ~~scenicall~~y there are notable variations due primarily to elevation and vegetation differences. Areas of greater elevation range generally have more abrupt and better defined physiographic features than are found in the Colstrip area. The most visible evidence of these areas are the Bull Mountains (elevations range 3,100 to 4,700 feet), the Rosebud Mountains (3,700 to 5,200 feet), the Wolf Mountains (3,300 to 4,700 feet), the Little Wolf Mountains (3,400 to 4,800 feet) and the Spray Mountains (3,300 to 4,500 feet). These landforms are characterized by steep terrain, exposed rock areas and well defined canyons and valleys. Locationally, all of these landforms are east and southeast of the Colstrip area, except for the Bull Mountains which are to the northwest.

In general, water features are scarce within this portion of the region, although water has had a significant influence on landforms and the distribution of vegetation.

A second major landscape type within a one-day travel zone is the higher elevation alpine mountains, which provide scenic amenities which are both different than and generally more spectacular than those found in most of Eastern Montana and the Colstrip area. Portions of both the Bighorn and Beartooth Mountains are contained within this region. The Bighorn Mountains are located to the south of Colstrip and lie mostly in Wyoming. The Beartooth Mountains are situated in the southwest extremity of the one-day travel region near Red Lodge, Montana. Both mountain ranges rise considerably higher in elevation than the other lands in this region. The Beartooths reach an elevation of 12,000 feet while the Bighorns rise to approximately 10,000 feet. By any standard, the alpine landscapes associated with these mountain ranges are highly scenic, containing numerous streams and lakes, as well as dramatic, shear rock facings, pine forests and meadows.

Although less visually dramatic, the Pryor Mountains, located at the northwest extreme of the Bighorn range, possess similar scenic amenities as the Bighorn and Beartooth Mountains. This range reaches elevations of approximately 7,000 feet. The landforms are predominantly steep to rolling, and are dissected by numerous live streams and drainages. Ponderosa pine and grasslands are the predominant vegetation types.

Open, rolling grassland areas containing numerous shallow gullies and ravines are another form of landscape commonly found in the travel region. Ranging in elevation from 2,800 to 3,100 feet, these grassland areas are generally devoid of both trees and water bodies, and are found primarily north and northeast of the Bull Mountains as well as to the south of Billings. The degree of variation in topography and diversity of color and texture associated with this landscape is considered less than that found in the Colstrip area.

Flat, open agricultural valleys create yet another dominant visual landscape within this region. These areas are located primarily in the western portion of the region between Billings and the Bull Mountains and are characterized by their vastness, with varying patterns and textures created by the agricultural activity interspersed with occasional glacial lakes. In general, these areas do not possess the level of visual interest or integrity associated with the landscape found in the Colstrip area.

Portions of the Crow Indian Reservation contain badland areas, which differ significantly from those landscapes previously described. These areas are characterized by rugged topography and colorful, horizontal bands of exposed soils and rock. As such, they represent a somewhat unique scenic feature in the region.

Another isolated and visually significant area is the Bighorn Canyon and Reservoir. Designated a National Recreation Area, it is a popular recreational site due to its proximity to water and superb scenic amenities.

The presence of water generally enhances the visual interest of the landscape, particularly in areas where water features are somewhat scarce. The major rivers within the one-day travel zone include the Yellowstone, Tongue, Musselshell, Bighorn and Little Bighorn. Many of these rivers are characterized by broad, flat valleys which have been developed to varying degrees because of the availability of suitable terrain and water. Therefore, the scenic quality of these river-dominated landscapes tends to vary significantly due to the integrity of the setting.

Quality of Mining Areas A and E Visual Resources According to BLM Ratings of Southeastern Montana and Northern Great Plains Region: This section focuses specifically on the visual amenities of the Mining Areas A and E that have previously been evaluated for their scenic quality by the Bureau of Land Management (BLM). The BLM is the only governmental agency which has conducted such studies on scenic quality in eastern Montana, providing, therefore, some frame of comparative reference.

This discussion will prove helpful in placing the visual resources associated with Areas A and E into regional perspective.

The BLM evaluated the lands according to the degree of scenic diversification provided by the landforms, color, water and vegetation inherent to the landscape. Lands were given additional importance if they contained any regionally unique features; and finally, the effects of many are considered. The evaluation criteria are included in table 1.

Based upon the rating given in each of these categories, the lands are placed in one of three scenic quality and related management practices categories as shown below:

Class A: The outstanding, rare areas where the superlative quality of the landscape dictates a management policy of protection of the scenic values in all land use decisions.

Class B: Above average scenery--although scenic values are high, they are not necessarily the dominant facts in determining management practices.

Class C: Average scenery--protection of scenic qualities does not determine land management practices.

The South Rosebud Planning Unit, evaluated by BLM, includes portions of the east and west fork of Armells Creek, Rosebud Creek and the Tongue River and those areas lying between them. This region has numerous intermittent streams, creeks and drainages, deeply dissected plateaus and valleys. Ponderosa pine covered hills with exposed brightly colored soils and frequent plateaus and valley of grasslands and shrubs and rock outcrops dominate the visual character of the landscape.

None of the lands were classified by the BLM as Class A scenery. Streams and related grassland and valley areas were generally placed in Class C, while ridges and hills having ponderosa pine and exposed soil colors were classified as Class B.

Table 1: BLM SCENIC EVALUATION SHEET

KEY FACTORS	A	B	C
Land Forms	Vertical or near vertical cliffs, spires, highly eroded formations, massive rock outcrops, severe surface variation.	Steep canyon walls, mesas, small scale erosional patterns, variety in size and shape of land forms.	Rolling hills, foothills, flat valley bottoms.
	4	2	1
Color	Rich color combinations variety or vivid contrasts in the color of soil, rocks, vegetation or water.	Some variety in colors and contrast of the soil, rocks and vegetation, but not dominant.	Subtle color variations, little contrast, generally muted tones. Nothing really eye catching.
	4	2	1
Water	Still, chance for reflections or cascading white water, a dominant factor in the landscape.	Moving and in view or still but not dominant.	Absent or present, but seldom seen.
	4	2	1
Vegetation	A harmonious variation in form, texture, pattern and type.	Some variation in pattern and texture but only one major type.	Little or no variation, contrast lacking.
	4	2	1
Uniqueness	One of a kind or very rare within region.	Unusual but similar to others within the physiographic region.	Interesting in its setting, but fairly common within the physiographic region.
	6	2	1
Intrusions	Free from aesthetically undesirable or discordant sights and influences.	Scenic quality is somewhat depreciated by inharmonious intrusions, but not so extensive that the scenic qualities are entirely negated.	Intrusions are so extensive that all scenic qualities are entirely nullified.
	2	1	-4
	TOTAL SCORE: 15 or more = Class A	10-14 = Class B	0-9 = Class C

APPENDIX E-7

ECONOMIC-DEMOGRAPHIC SIMULATION MODEL

APPENDIX E-7

A. The Model[1]

The economic-demographic simulation model provides a framework within which the interaction of the demographic structure and the economic base of the study can be studied. The components of the model and the purposes they serve are as follows:

> Demographic Submodel: This submodel starts with a base population of the study area and predicts the number who are expected to be born and die during the year. Part of the new population then joins the labor force based on a set of assumed age-sex-race specific labor force participation rates. The output of this submodel includes population and labor force.
>
> Economic Submodel: The economic submodel begins with the assumptions about the level of basic activity in the area and generates the local employment and real income levels by industry.
>
> Racial Allocation of Employment Submodel: The available Northern Cheyenne labor force is compared to the total number of jobs assumed to be available to the Cheyenne. The proportion of new jobs in a given industry that will be available to the Cheyenne is referred to as the Northern Cheyenne "entry factor" and was estimated to reflect both the historical level of participation of the way in which this might change in the future. Northern Cheyenne employment is then determined by whichever factor becomes limiting first--available labor force or available jobs. Possible non-Indian employment by industry is then calculated by subtracting the Indian employment from the total.
>
> Migration Submodel: The Anglo total employment is then compared to the available Anglo labor force from the demographic submodel and the implied unemployment rate is calcualated. If this rate is outside the normal range, migration is assumed to occur to bring the rate within the range. The in-migrants (out-migrants) are then added (subtracted) to the base population, and the model proceeds to the next year.

The model generates five basic tables:

(1) Population--Age, Sex, Race

(2) Labor Force--Age, Sex, Race

(3) Employment--Race, Industry

(4) Unemployment Rate--Race

(5) Labor Income--Race

The interrelationships of the four submodels and more detail about the way in which their components interact are shown in figure 1.

B. Important Demographic Assumptions

The vital rates (both birth and death) of the population and the labor force participation rates of the area residents are important factors in determining the impact of resource development on Rosebud County.

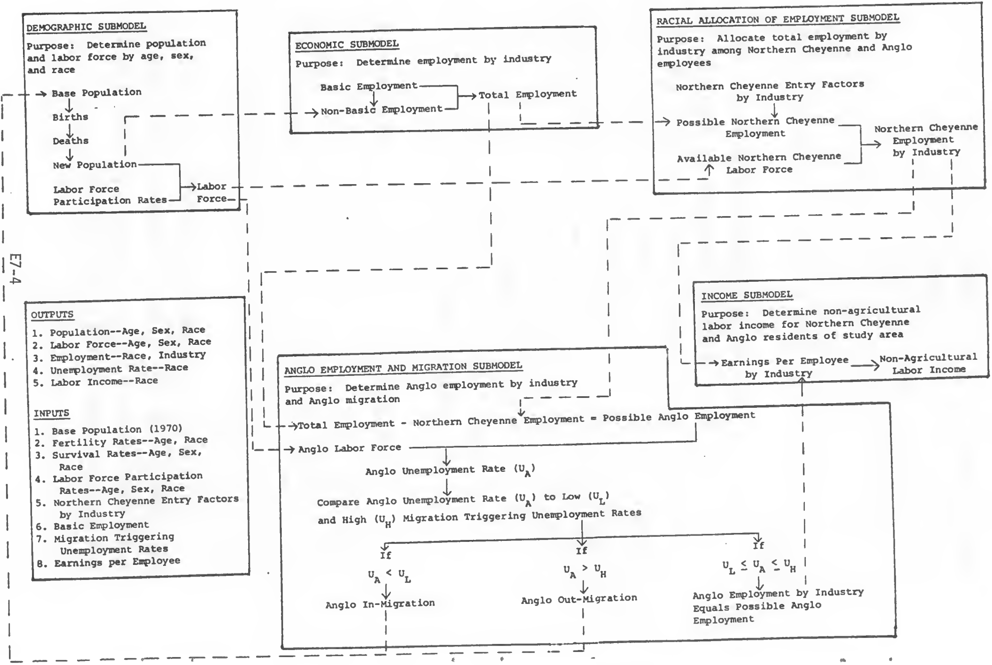
Fertility rates were derived by taking the annual average number of live births over the period 1969-1971 by age and race of mother for the state of Montana and then calculating rates based on the 1970 census population. These rates were then examined further to check their applicability to the study area. Data provided by the Indian Health Service showed that fertility rates for the service unit containing the Northern Cheyenne Reservation are close to Montana all-Indian rates. These data also indicated that although there was a substantial decrease in the rates between 1960 and 1970 (from 246.8/1000 to 186.1/1000 women of child-bearing age), there is no evidence that there will be a decline of this magnitude over the decade of the 1970's.

This, with the importance of the large family to the Northern Cheyenne, leads to the assumption that future fertility rates will remain at the 1970 level. Although the rates could fall in the future, such a reduction would not significantly affect the size of the Indian labor force until after 1990. The reduction, however, would cause the Northern Cheyenne population to be smaller than projected.

Survival rates were obtained in much the same manner. Average annual deaths by age, sex, and race for the period 1969-1971 were divided by the 1970 census population in each age-sex-race group. These rates were assumed to remain constant at the 1970 level.

FIGURE 1

ROSEBUD COUNTY ECONOMIC-DEMOGRAPHIC SIMULATION MODEL


DEMOGRAPHIC SUBMODEL
Purpose: Determine population and labor force by age, sex, and race
Base Population
Births
Deaths
New Population
Labor Force Participation Rates
Labor Force
ECONOMIC SUBMODEL
Purpose: Determine employment by industry
Basic Employment
Non-Basic Employment
Total Employment
RACIAL ALLOCATION OF EMPLOYMENT SUBMODEL
Purpose: Allocate total employment by industry among Northern Cheyenne and Anglo employees
Northern Cheyenne Entry Factors by Industry
Possible Northern Cheyenne Employment
Available Northern Cheyenne Labor Force
Northern Cheyenne Employment by Industry
OUTPUTS
1. Population--Age, Sex, Race
2. Labor Force--Age, Sex, Race
3. Employment--Race, Industry
4. Unemployment Rate--Race
5. Labor Income--Race
INPUTS
1. Base Population (1970)
2. Fertility Rates--Age, Race
3. Survival Rates--Age, Sex, Race
4. Labor Force Participation Rates--Age, Sex, Race
5. Northern Cheyenne Entry Factors by Industry
6. Basic Employment
7. Migration Triggering Unemployment Rates
8. Earnings per Employee
INCOME SUBMODEL
Purpose: Determine non-agricultural labor income for Northern Cheyenne and Anglo residents of study area
Earnings Per Employee by Industry
Non-Agricultural Labor Income
ANGLO EMPLOYMENT AND MIGRATION SUBMODEL
Purpose: Determine Anglo employment by industry and Anglo migration
Total Employment - Northern Cheyenne Employment = Possible Anglo Employment
Anglo Labor Force
Anglo Unemployment Rate (U_A)
Compare Anglo Unemployment Rate (U_A) to Low (U_L) and High (U_H) Migration Triggering Unemployment Rates
If
$U_A < U_L$
Anglo In-Migration
If
$U_A > U_H$
Anglo Out-Migration
If
$U_L \leq U_A \leq U_H$
Anglo Employment by Industry Equals Possible Anglo Employment

The most important demographic assumptions are those that relate to how the resident population will participate in the labor force. This concept is referred to as the labor force participation rate (LFPR) and is a measure of the number of employed and unemployed persons seeking work expressed as a percentage of the populatioon of working age. If, for example, there were 80 persons of a given race, sex, and age, and 50 of these were employed and ten were unemployed but seeking work, then the number in the labor force would be 60. The LFPR for this particular cohort would be 60/80 or .75.

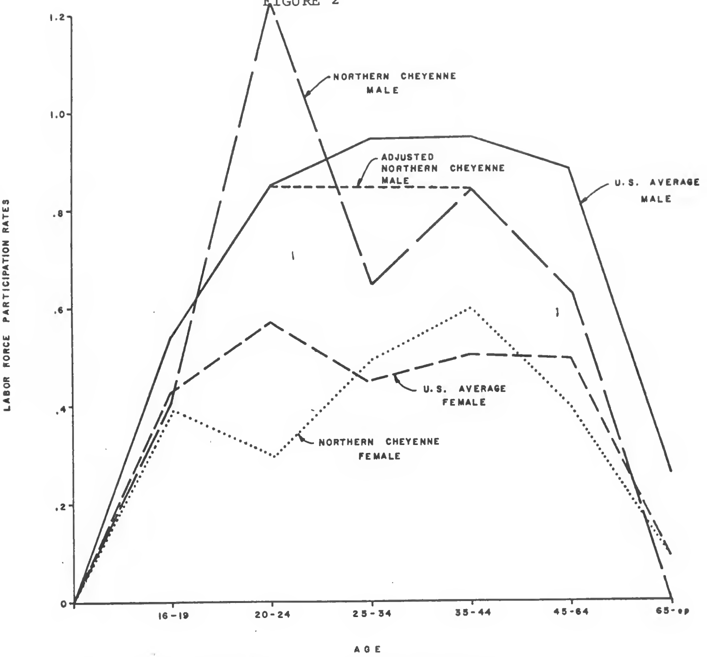
In general, the higher the LFPR, the smaller the population necessary to fill a given number of jobs. This results in a higher level of per capita income, since the ratio of employed persons to total population is higher. In order to do any analysis of the impact of future events, it is necessary to look carefully at the LFPR of both the Anglo and Northern Cheyenne residents in the study area. The Indian and Anglo LFPR along with the U.S. rates are graphed in figure 2 and figure 3.

The rate for 20-24 year old male Northern Cheyennes was calculated to be greater than one, which means that there are more males of this age in the labor force than there are total males of this age. Clearly, this is not reasonable. Furthermore, the rate for 25-34 year old Northern Cheyenne males were combined with the resulting LFPR indicated by the light, dotted line in figure 2. The same results were observed for the Anglo males with both the 20-24 and 35-44 rate greater than one and the 25-34 rates too low. These three age groups were combined with the LFPR indicated in a like manner in figure 3.

The pattern of participation for Northern Cheyenne males and females is somewhat below the average participation for the United States as a whole. Likewise, labor force participation for Anglo women in the study

LABOR FORCE PARTICIPATION RATES
NORTHERN CHEYENNE
1970

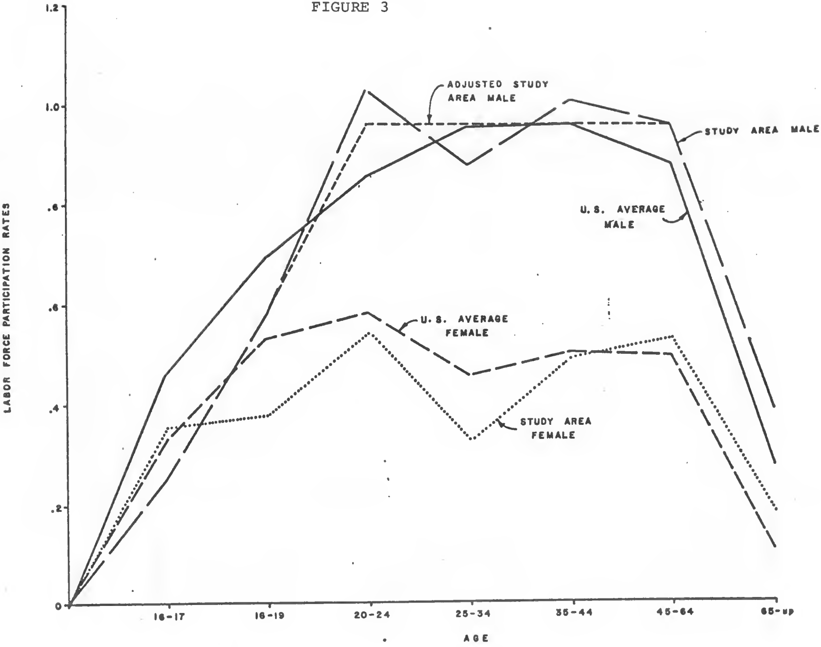
FIGURE 2



Sources: Derived from U.S. Bureau of the Census, Summary Tape Data.
"U.S. Labor Force: Projections to 1990", Monthly Labor Review (July, 1973).

LABOR FORCE PARTICIPATION RATES
ANGLO
1970

FIGURE 3



Sources: Derived from U.S. Bureau of the Census, Summary Tape Data.
"U.S. Labor Force; Projections to 1990," Monthly Labor Review (July 1973).

area is below that for U.S. women. It is well known that persons drop out of the labor force (i.e., no longer "actively" seek work) if, over an extended time, they fail to find employment. However, these discouraged labor force participants may rejoin the labor force if employment opportunities become available in the area. As coal development activity increases in the study area, it would be unrealistic to assume that the LFPR will remain at the 1970 level.

For this reason, the futures analysis has assumed that the participation rates will converge to projected U.S. rates by the year 1990. This represents an upper limit to the level of participation in the study area and has the desirable property that the bulk of the adjustment will come from increased participation of young people facing the labor force entry decision for the first time. It is highly likely that these young people, if opportunities exist, will participate in a way increasingly similar to their age-sex counterparts elsewhere in the United States.

C. Important Economic Assumptions

A critical question of the analysis of future developments in the study area concerns the racial distribution of the jobs that are created. Clearly, it is not sufficient to simply talk about the total number of jobs to be created; the distribution of the jobs between Northern Cheyenne and Anglo workers must also be addressed. The employment of Northern Cheyennes by industry was approached in the following manner:

> The available Northern Cheyenne labor force was calculated. This was assumed to be .95 of the total labor force, i.e., "normal" unemployment was assumed to prevent the unemployment rate from falling below five percent. However, the rate can still go above this level.
>
> An assumption was made about the proportion of new jobs in any given industry that would be available to the Northern Cheyennes. These "entry factors" reflect both the historical level of participation of the Cheyennes in a given industry plus an estimate of the way in which conditions might change in the future. For example, even though there were no Cheyennes working in the mining sector in 1970, it was assumed that they

> would have access to fifteen percent of the new mining jobs that become available. This means that if enough Northern Cheyenne workers are available, they will get ten percent of the jobs.

Although the 15 percent entry factor seems low for the mining and construction sectors, the attitude of some people on the reservation is that the energy companies have not and will not employ a substantial number of Northern Cheyenne because of problems associated with skill, absenteeism, and discrimination. The validity of the 15 percent figure will depend on the hiring practices of the development companies; but it should allow the estimation of at least the order-of-magnitude of the impacts on the Northern Cheyenne. The entry factors along with the 1970 distribution are shown in Table 1.

Application of the entry factors to the number of new jobs in an industry then generates an estimate of the number of jobs available to Northern Cheyenne workers. If the available Northern Cheyenne labor force exceeds the available jobs, then actual Northern Cheyenne employment is assumed equal to available employment by industry, and the difference between the Northern Cheyenne labor force and employment is the number of unemployed.

If the number of available jobs exceeds the available Northern Cheyenne labor force, Northern Cheyenne employment is limited to the available force, the unemployment rate is five percent, and the available Northern Cheyennes are allocated by industry proportionally. In either case, Anglo employment by industry is calculated as the difference between total employment and Northern Cheyenne employment.

The other set of assumptions for the economic model concerned the responsiveness of the service and trade sectors (induced activity) to new income in the area. This new income will be generated by changes in agriculture, mining, or manufacturing activity.

TABLE 1

ENTRY FACTORS FOR ROSEBUD COUNTY

Sector	Entry Factor	Percentage of jobs held by Northern Cheyennes (1970 Census)
Agriculture	.18	18.0
Mining	.15	----
Construction	.15	.1
Manufacturing	.70	73.6
Transportation, Communication, Public Utilities	.15	11.4
Trade	.15	7.7
Finance, Insurance, Real Estate	.11	11.0
Services	.25	19.2
Government	.50	41.3
Other	.05	----

Source: Derived.

The short time series of employment and income data (five years) makes it questionable whether analytic estimation of this relationship can be done. Furthermore, it is not clear that such sophisticated analysis would be more reliable than a simpler method given the amount of structural change occurring in the county.

It is quite reasonable to assume that induced activity is directly related to the level of income in the study area. Thus the level of induced employment can be expressed as a fraction of labor income and is the ratio of a particular sector's employment to income. If trade employment, for example, was 100 and income was 10.0 million dollars, the ratio would be .00001; or, for every dollar of income, there are .00001 employees in the trade sector, Thus one additional person will be employed in the trade sector for every $100,000 of additional income.

Induced employment is assumed to occur in the following seven sectors:

(1) construction

(2) transportation, communication, and public utilities

(3) trade

(4) finance, insurance, and real estate

(5) services

(6) government

(7) other (self-employed)

Clearly, not all of the employment in each of these sectors can be attributed to residential activity within the county. One of the more obvious sectors for which this is the case is the transportation sector. Employment in the railroad industry is not related to the level of income in the study area, and if this "basic" activity is not removed from the employment total before the ratio is calculated, the ratio will be too high and this will cause the industry to grow too fast. Therefore, the following adjustments were made.

(1) Railway employment was removed from the transportation sector.

(2) Non-profit and welfare organizations were removed from services.

(3) State and federal employment was removed from the government total.

(4) The ratio for the "other" sector was calculated as a weighted average of the ratios for the trade, finance, and service sectors.

The ratios, both before and after the adjustments, are given in Table 2. As indicated, the adjustments had a substantial effect on the size of the ratios.

TABLE 2

RATIOS OF INDUCED EMPLOYMENT TO LABOR INCOME (EMPLOYEES PER $1,000 PERSONAL INCOME)

Sector	Unadjusted	Adjusted
Construction	.0014	.0014
Transportation, Communication, Public Utilities	.0088	.0035
Trade	.0104	.0104
Finance, Insurance, Real Estate	.0009	.0009
Services	.0189	.0109
Government	.0212	.0125
Other	.0148	.0083

Source: Derived.

APPENDIX F

CORRESPONDENCE AND PUBLIC COMMENTS AND RESPONSES ON THE DRAFT IMPACT STATEMENT

IN REPLY REFER TO:
1792 (960)

United States Department of the Interior
BUREAU OF LAND MANAGEMENT
222 North 32nd Street
P.O. Box 30157
Billings, Montana 59107

JUL 27 1977

Mr. Brace Hayden
Environmental Coordinator
Department of State Lands
Capitol Station
Helena, Montana 59601

Dear Mr. Hayden:

Thank you for the opportunity to comment on the Draft Environmental Impact Statement on Western Energy Company's Rosebud Coal Mine proposed expansion into Areas A and E. Both areas A and E outlined in this EIS fall within our Colstrip B proposed coal lease tract, within the Northern Powder River Regional Coal EIS. Our Colstrip Tract B includes a much larger area encompassing Western Energy Company mining areas A, B, C, and E plus additional land south of areas B and E. See accompanying map.

Therefore, we are naturally concerned that any decisions made regarding any one or all of the mining areas and the decision regarding the Colstrip Tract B are consistent with one another. Notwithstanding the requirements of state law, any decision on the part of the state to issue the permits applied for could seriously affect the overall requirements to be established later should federal coal in Colstrip Tract B eventually go to lease as a result of the Regional EIS. We also wish to point out, as far as time requirements are concerned, that should Tract B survive the test of the Regional EIS, we must still conduct a technical examination and complete an Environmental Assessment Record prior to including the tract in any leasing proposal to the Secretary of the Interior.

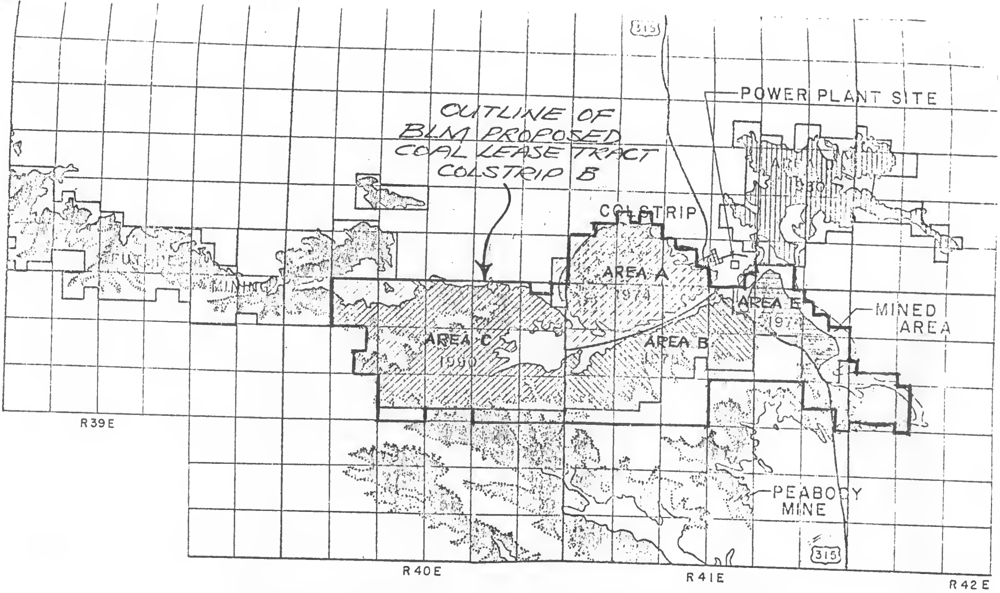
We would like to get the benefit of a review of your EIS currently being conducted by the Northern Powder River EIS task force before presenting our comments on the technical aspects of the document. We fully appreciate your time constraints, and will expect to get our comments to you no later than August 5.

Sincerely yours,

Kannon Richards
Acting State Director

Enclosure

cc:
DM, Miles City



COLSTRIP COAL DEPOSIT—ROSEBUD SEAM

(MATSON & BLUMER 1973)

Source: Montana Department of Natural Resources and Conservation, 1974, Draft EIS on Colstrip Electric Generating Units 3 and 4, 500 kilovolt Transmission Lines and Associated Facilities, Helena, Montana, Volume 3A, p. 259.

N

〰 - Limit of Rosebud

┈ - 150 Ft. Overburden Limit

Figure 2

United States Department of the Interior
BUREAU OF OUTDOOR RECREATION
MID CONTINENT REGION

MAILING ADDRESS:
Post Office Box 25387
Denver Federal Center
Denver, Colorado 80225

STREET LOCATION
603 Miller Court
Lakewood, Colorado
Telephone 234-2634

IN REPLY REFER TO:

JUL 11 1977

Mr. Brace Hayden
Environmental Coordinator
Department of State Lands
Capitol Station
Helena, Montana 59601

Dear Mr. Hayden:

We have reviewed the draft environmental impact statement for the proposed expansion of coal-mining activity by Western Energy Company in the Rosebud Coal Mine and believe that the interests of this Bureau have been adequately addressed. Therefore, we have no comment.

Sincerely,

Robert F. Stewart
for Robert J. Arkins
Assistant Regional Director
Land Use Coordination

OFFICE OF THE DIRECTOR

March 3, 1849

United States Department of the Interior
BUREAU OF MINES
2401 E STREET, NW.
WASHINGTON, D.C. 20241

In Reply Refer To:
EBM-MMSDA-AD-FO

July 28, 1977

Environmental Coordinator
Department of State Lands
Capital Station
Helena, Montana 59601

Dear Sir:

We have reviewed the draft environmental statement for the proposed expansion of Western Energy Company's Rosebud Mine into Areas A and E, Rosebud County, Montana. Discussion of geology and mineral development are comprehensive in the statement; we have no suggestions for improvement.

Sincerely yours,

Morgan

Acting Director

AMERICAN REVOLUTION BICENTENNIAL
1776-1976

ECOLOGICAL CONSULTING SERVICE

ECON INC.
Airport Way Building West
1300 Block, Cedar Street
Helena, Montana 59601
Telephone
406/442-4650

July 14, 1977

Mr. Leo Berry
Commissioner of Lands
Montana Department of State Lands
1625 Eleventh Avenue
Helena, Montana 59601

Attention: Mr. Brace Hayden

Dear Brace:

Our comments on the DEIS for Western Energy Company's Rosebud Mine in areas A and E are as follow:

The wildlife studies in the immediate Colstrip vicinity started in 1972 and have continued to the present. Although the population of Colstrip has fluctuated, the observed seasonal distributions of various wildlife species has remained relatively unchanged in the five-year period. Since 1973, the 10X20 study area, which includes areas A and E, has been flown systematically at low level and low speed for wildlife observations throughout the year.

It should be noted that vegetation mapping and monitoring has been assisted by utilization of at least annual peak-of-green stereo metric (9"X9") aerial false color infrared of the entire 10X20 since 1973.

Thank you for the opportunity to respond to the DEIS.

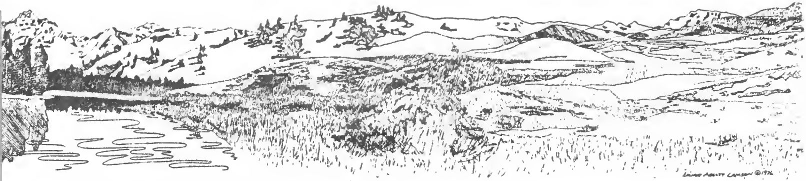
Sincerely,

Bob

Robert E. Carroll
Vice President and General Manager

REC:jw

Environmental Applied Research • Wildlife Baseline & Monitoring • Aquatic Baseline & Monitoring • Vegetation Research & Mapping
Applied Remote Sensing • Natural Resource Surveys & Inventories • Air & Water Quality Research • Environmental Impact Assessments



Environmental Information Center   Box 12, Helena, MT 59601   (406) 443-2520

RECEIVED
'77 JUL 15 PM 4:59
STATE OF MONTANA
DEPT. OF STATE LANDS
AND INVESTMENTS

July 15, 1977

Mr. Brace Hayden, Environmental Coordinator
Department of State Lands
1625 Eleventh Avenue
Helena, MT 59601

Dear Mr. Hayden:

The Montana Environmental Information Center, a state-wide citizen organization, respectfully submits the following comments on the draft environmental impact statement for the proposed expansion of Western Energy's Rosebud mine into areas A and E.

Generally, we feel the draft E.I.S. is a good attempt at what always is a complex and difficult process -- delineating the impacts a development will have on a physical, biological and social community. Certainly, a few features of the E.I.S. stand out as innovative and imaginative, such as the the table on pages 60-65, "Vegetative Composition of Areas A and E." This is the first time we've examined an E.I.S. with such a breakdown of species, and it strikes us as an example of the useful information MEPA can provide to help us all make sounder, more defensible resource decisions.

Of course, we don't mean to say the draft E.I.S. is as strong on all accounts. We did an in-depth analysis of other parts, and discovered several apparent and serious problems. The air quality content of the E.I.S. serves to illustrate this.

On page 24, the description of the existing environment seems sparse, with the only conclusions seeming to bear out the contention that present operations are regularly and systematically violating both state and federal standards for dust and total suspended particulates.

Information on pages 142 to 145 indicates a continuation of this practice, "...loading essentially the same levels of fugitive dust to the air as are being experienced during current mining..." We feel the plan for the expansion of the mine should attempt to meet all state and federal air quality standards, not continue the same dismal track record as the existing operations apparently have.

There are numerous vague and imprecise words and phrases throughout the air quality sections: "conditions appear to be marginal"; "standards may be exceeded"; "possible respiratory effects on humans and animals"; "significantly increase", and "controlled to the fullest extent practicable." We are also disturbed at the comments on page 158 which show problems with dust affecting vegetation, livestock and wildlife, and the statement that "...the deterioration of air quality is expected to be within acceptable standards except possibly locally under unusually stable conditions or immediately adjacent to mining equipment."

Certainly, such potentially serious impacts on humans, vegetation and animals deserve a comprehensive, detailed analysis to insure that the environmental protection provisions in both the Montana Strip and Underground Mine Act and the Montana Environmental Protection Act are met.

Finally, the short statement in the Mitigating Measures section on air quality hardly seems to deal with the problems, both potential and proven, that are associated with this project. We would ask how many other E.I.S.'s since 1975 have noted these same problems...and dismissed them with vague phrases and "possible promises." We hope this will not be one more such evasion of air quality standards.

The comments and criticisms we outlined on the air quality sections could be made for other parts of the E.I.S. We will not list them here; your staff can use their expertise more effectively in that way. But we hope your department will use these comments to continue the start it made in this draft to accurately and completely assess the impacts of this project and to develop a strong management plan to alleviate all negative impacts. We look forward to your leadership in this field.

Sincerely,

Alan Abramson,
EIC staff

Forsyth, Montana
June 22, 1977

Mr. Leo Berry, Jr.
Commissioner, State Lands
Dept. of State Lands
Helena, Montana

Dear Sir:

Re: Headline "Coal gets nod over Agriculture."

It would be prudent if your Department exercised even the rudiments of courtesy to Montana citizens BEFORE the above public announcement.

The more tasteful approach would be: A. Provide a copy of the EIS to all those in Agriculture who'se lands might be adversely affected by the strip-mining operation.

And B. Hold a public hearing with regards those particular permit extensions.

To learn via newspaper that Agriculture is expendable to Coal is, to say the least, an insult to this family which has paid taxes to the state coffers for a span of ninety three (93) years.

Having extended the courtesy to various of your State Environmental teams for several years, on our ranch holdings on Cow creek and Rosebud creek, We are now totally aware it was an exercise in futility. Those scientific experiments are to be obliterated by the State's lust for the Coal tax fund.

Very truly yours,
Mrs E. M. Kluver
Mrs. E. M. Kluver

June 24, 1977

Mrs. E. M. Kluver
Route 1, Box 24
Forsyth, MT 59327

Dear Mrs. Kluver:

I am in receipt of your June 22, 1977 letter regarding the draft impact statement for Western Energy Company's latest mining proposals in Areas A and E. Enclosed is a copy of that statement; my apologies for not having sent you one. We have a master mailing list for impact statements and we will certainly add your name.

I must admit that my reaction to the referenced headline was similar to yours. The department made no public announcement nor were we contacted by the press. Once an impact statement is filed it becomes a public document and most are subject to review by the various newspapers and wire services. Unfortunately, the headline was not consistant with, nor a fair interpretation of, what was actually contained in the impact statement.

It appears that the headline and article are based on a sentence found on page 223.

> "Under present economic conditions and national priorities, the demand for coal greatly exceeds that of the agricultural products raised in the Colstrip area."

The statement obviously did not attempt to make coal more important than agriculture. It was merely an attempt at an objective statement of the present and future demands for coal and the unfortunate discouraging state of our farming and ranching industries. While the demand for and price of coal has escolated sharply in recent years the same cannot be said of the agricultural products. Again, the department by no means meant to place more importance on coal than agricultural products. In fact, several other portions of the impact statement reflect the importance of the agricultural industry. In particular, I refer you to pages 167, 202 and 203. The impact statement also notes that coal is only a short term source of energy and that the long term productivity of the land must be maintained. In fact, a fundamental purpose of Montana's reclamation is to insure that the land is returned to a productive agricultural role; in addition those areas which are critical, exceptional or unique, as defined by the law, must be deleted from mining. The language on page 228 will be changed in the final statement so that no misunderstanding will occur.

Your suggestion that the impact statement be mailed to the landowners directly affected is a good one and the department will make the necessary modifications in its procedures. The department may not always know who is interested in the statement. However, anyone who desires to be placed on the mailing list need only advise the department. Hearings are not normally held on the statements unless a large public interest is anticipated.

I certainly hope that I have addressed your concerns. If not please feel free to contact me. You are also encouraged to submit written comments on the draft statement.

Sincerely,

Leo Berry, Jr. Commissioner
Department of State Lands

sm

Enclosure

[illegible]
Forsyth, MT 59327

Forsyth, Montana
July 14, 1977

Montana Department of State Lands
Helena, Montana

Dear Sirs:

Having only briefly scanned the E.I.S. submitted relative to the proposed expansion of Western Energy Company's Rosebud mine into Areas A and E, I must point out the odd mistakes encountered thus far:

On your map on P. 57, in townships 1 N and 2 N, Range 42 E, there are a number of GROSS errors. Since we have permitted, even encouraged the State Land Dept. personnel to examine all the wells on our holdings, the fact that they came up with the implication that there were few wells or springs in the area, but that the area was watered by a number of non-existant reservoirs is, to say the least, inexplicable. ARE YOU AWARE THAT, IN THIS AREA, THE GOVERNMENT A.S.C.S. OFFICE DOES NOT ENCOURAGE THE BUILDING OF RESERVOIRS BECAUSE THE SOIL WON'T HOLD WATER?

In our land, alone, in those townships, there are five (5) well sites unmarked, as well as a number of springs. Many of the reservoir sites are an obvious error or distortion.

In line with your responsibility to the citizens of the State, would you please arrange an appointment with me to tour the area of distorted mapping. I would like the State Land Dept. to have a record of the wells and springs prior to the coal development. Obviously, the State Land Dept. won't refuse the permit becouse to quote the Miles City Star, "Coal Gets Nod Over Agriculture."

Very truly yours,

Mrs. E. M. Kluver

WESTERN ENERGY COMPANY
GENERAL OFFICES: 40 EAST BROADWAY, BUTTE, MONTANA 59701

August 25, 1977

Mrs. E. M. Kluver
Forsythe, MT
59327

Dear Mrs. Kluver:

In your letter of July 14, 1977 to the Montana Department of State Lands, you referenced the fact that certain wells and springs on your property southeast and east of Western Energy's mining areas have not been mapped. I am interested in the fact that these wells and springs have not been mapped and I would like to inquire as to the possibility of gaining access to these sites for mapping and sampling purposes.

We are concerned about what effects our mining will have on the various aquafers in the Colstrip area and, therefore, we would like to be able to record all wells and springs and monitor any possible changes that may take place due to our mining activities. I feel that our intentions will be in the best interests of both you and Western Energy. I respectfully hope that we can cooperate in the assessment of this matter and work together to determine what effects mining will have on your wells and springs.

Please let me know what your thoughts are on this matter and I will be more than happy to meet with you and work out the necessary arrangements.

Sincerely,

Mike Grende

Michael R. Grende
Permit Supervisor

MRG/llm/3:5

cc: Brace Hayden

Stan Walthall
Sociologist
NPRB EIS Team

CRITIQUE of the DRAFT ENVIRONMENTAL IMPACT STATEMENT, WESTERN ENERGY'S AREAS A and E: SOCIAL IMPACTS

C. HUMAN ENVIRONMENT

1. POPULATION

General discussion on population change is limited to 1950 and 1970. Some major implications of this short term look at change in the area excludes long term trends. How is it known for instance, that "increases in agricultural production caused further population losses". Further in the discussion of fertility it is suggested that non-Indian counterparts are more likely to move from the area "in response to changing economic conditions". I suggest this may be false and in contradiction to the literature concerning white traditions in the area, and a specific attachment to the land that has developed while enduring more extreme hardships. This would be true for Wyoming for instance.

In addition, there is no discussion of population density and distribution. What areas are crowded or overpopulated, how many people/sq. mile are there, and how is this population density related to the predominate way of life for both Indians and whites? What is the age structure? This data is important in planning necessary to alleviate school problems. Natural growth is said to be higher for non-Indians, how much so and are the differences significant?

If growth is to be evaluated, and it must be as population increases, are the major source of social problems in resource development, current growth rates must be examined and compared with population influxes due to the mining operation.

Population estimates between 1970 and 1976 were not compared to and discussed with the special county census of 1976. Why not?

No discussion was presented of flucuating populations in Colstrip during the period of 1970 to 1976. This information is important in looking at "boom or bust" population cycles for mitigation in later chapters. Is this information available?

2. SOCIAL STRUCTURE

Social structure is defined (Remmling and Campbell, 1970:367) as: "The continuing interrelationship among people which permit them to identify each other by position." Briefly it describes the place of members in their society, not the way in which society is produced by its members. With large numbers of workers coming into an area to build power plants, operate mines and fill secondary jobs, it is of the utmost importance to describe the manner in which these new comers affect the way locals are and have traditionally interacted. Some of these intrusions have been documented by research done at the Institution for Social Research at the University of Montana on the Colstrip Area and the Decker-Birney-Ashland area. Why was not the most current literature sited rather than some of the earlier?

Page 102 suggests that:

> An underlying assumption that has been made of the people surrounding Colstrip are generally conservative in cultural, religous and general social matters, and a characteristic, which may be most applicable to those residents who have lived in the area for longer than seven years.

While this sentence has been quoted directly out of the text, there is no connection to the previous quote from the NGPR study nor the following sentences. What does this mean? So what if people are conservative in nature, the statement needs to address itself to coal mining expansion How does their conservative nature affect the way they are being effected by such development?

There is a number 8, referring presumably to a footnote which is non-existant. What is the source of this statement? This statement should be challenged whether it is referenced or not. Existing studies indicate that locals no not feel allienated, so much by "eastern" interests and policies of the BLM, as they go by what they feel has been dishonesty and deceit on the part of local federal and state agencies as well as private corporations in their dealings with them.

Ranchers and farmers of the area also hold a "land ethic" developed from their survival of very extreme conditions including "dust bowls", "depressions" and low cattle and produce markets. Also the smallness of their holdings, as compared to similar operations in Wyoming have tended to give them a closeness to the land lacking in both their North Dakotan and Wyoming counterparts.

There is no description of what life is like now for both locals and newcomers. How can the impact of new people on the area be evaluated if it is not based in present conditions?

There is no description or discussion of the present "social structure" of the area, although this is the title of this section. This section is interesting as far as it goes, but it does not go far enough to be useful in assessing the social impacts to the area if the mine is expanded. It simply does not offer enough information to ground further analysis.

6. SOCIAL SERVICES

The description of social services is better than most found in environmental impact statements. One suggestion for improving this section would deal with the "social" implications of each section in detail including more on the existing problems of delivering services and maintaining facilities.

III. ENVIRONMENTAL IMPACTS

C. HUMAN ENVIRONMENT

1. Population and Economics

This section suffers primarily due to problems in the description of the existing environment. Problems with granting or not granting the permit could be discussed in a more flowing, natural manner if Chapter II were improved.

No extension of the social structure section is found. What is the purpose of having that discussion if its threads are not carried through? What are the social implications of not granting the permit to the locals: ranchers, then farmers, then townspeople, in terms of the newcomers?

How does this operations contribute to the regional social impacts of Mining in the Northern Powder River Basin?

The population scenerios are interesting and appear well thought out given data constraints. They should however deal only with the enumeration and county census division levels and include only the area south of the Yellowstone and north of Ashland.

What are the social implications of extending the mines in terms of time and the concentration of impacts from other activities?

CONCLUSIONS:

Of major importance is the significance of an adequate water supply and optimum productivity of the land to the way of life of the people in the area. The population density is important to the maintenance of an agricultural way of life while growth degrades the quality of the existing way of life. Meaning and worth are related to the quality of the land system including water, air and productivity of the land, as well as the continuance of the existing social system. Change without direction "pulls the rug" sort of speak, out from under local society. Orderly change can be tolerated and assimilated by locals, but what direction that change takes must be grounded in local conditions, and these have not been described.

MEMORANDUM

DATE: July 15, 1977

TO: Joe Elliott
FROM: Dwayne Ward
RE: Comments on Draft EIS on Western Energy's proposed Areas A and E Expansion

The strongest portion of the economics of document appears in "Description of the Existing Environment" section. There is a decent sketch of employment and income, though there should be some measure of the relative importance of the various industries in the county (a standard index could, for example, be provided by employment and income location quotients). As it stands, the document is quite impressionistic and relies on a narrative to sort out the relative importance of industries, rather than offering some kind of quantitative measure. A strength of the document is the extent to which the situation of the Northern Cheyenne population is considered (though a judgement about the adequacy of the treatment should be left to the Northern Cheyenne). Importantly, the document concerns itself, to some extent, with income comparions between Rosebud County and the State (and indicates that it is, and has been historically, statistically lower). The sections on social services, by community, are also informative.

Chapter III, in contrast, seems both more flawed and much more difficult to follow--some of it, in fact, seems quite muddled. On Page 167, for example, the section there on agriculture seems misplaced--perhaps it should be contained in the existing environment section (at least the first paragraph). On Pages 168 and 169, it is not clear at all what the basis for increased employment in the wood products industry would be. Section D, beginning on Page 170, is where the document becomes very confusing. Basically the "model" utilized offers four different coal extraction and electricity generation possibilities, with corresponding construction possibilities. On Page 171, in the second paragraph is the statement that there is a subtraction of employment loss (if the mining permit is denied) from the previous two tables. These tables refer to agriculture and wood products and it would seem that, if anything, the subtraction should be from total projected county employment, not just these two sectors. At the bottom of the page, it is noted that a constant assumption is that there will be two additional mines in the county of ten million tons a year production each. Perhaps an additional county employment scenario is needed--one that assumes no additional coal mines. Tables 42 and 43 are somewhat confusing--the title refers to employment change associated with permit denials. It is unclear if this is from previous years (that is, the year preceding each change) or from estimates if the permits are approved. On page 174, it is noted that the assumption of additonal coal mines near Ashland also assumes an additional railroad spur. I don't think that assumption is followed through with additional railroad construction workers and operating people, but it is impossible to be sure. The material on the second half of Page 176, under the title "population" is very unclear (as is the graphical depiction). A statement is made that all construction on Colstrip units 1 and 2 will stop in 1978. Hasn't this already occurred? On Page 178 (second paragraph) an employment loss is mentioned. It should be made clear whether this is between various scenarios or the present situation (it appears to be the former, but I'm not sure). On Page 181, is reference to a figure 26, which apparently does not exist. It is also claimed here that failure to permit A and E would result in the loss of employment of 27 Northern Cheyenne. My conversations with people around the area indicate that this probably grossly overestimates the number of Northern Cheyenne employed by activity at Colstrip, both direct and indirect. The graph on Page 178 seems conceptually wrong--Alternative Future 1 assumes that there will be no Colstrip Units 3 and 4. Yet, a boom cycle is indicated by the graph which is parallel to Alternative Future 2, which assumes construction of 3 and 4.

The economics of section VI, "Relationship Between local short-term uses of man's (sic) environment and the maintenance and enhancement of long-term productivity," does not deal with the issues implied by the title at all. It is stated that the issuance of mining permits would maintain the current economic environment through the maintenance of mining employment. It is not noted that the land there has alternative economic uses other than mining, such as agriculture. It would seem that comparatively short-term mining should be compared with the return from long-term agricultural use of the land (as well as other possible uses) as well as considering who benefits and who loses. Social phenomena are also not considered here and it could well be argued that the mining of more area will add to the destruction of an agricultural way of life and further damage more established social relationships in the areas.

In short, while this draft EIS gets off to a good start, the quality of the document declines steadily beyond the second chapter.

MEMORANDUM

DATE: July 15, 1977
TO: Joe Elliott
FROM: Bret Brunner
RE: Comments WECO Areas A and E

Overall, the statement is very uneven. Some areas are very good and some are completely deficient of data and analysis. Substantial work needs to be done to make it adequate.

The graphics are terrible. They are poorly made with poor data and are badly reproduced. Any one of them for example. None of the maps label Pit 6. The mined areas are not consistently indicated, nor is it indicated by whom the mining was done. There are old spoils, old mines, old mines being extended and new mines. These should be clearly shown. It would also help to map the previous permits.

It is assumed, in many places, that reclamation works. Impacts are determined on this assumption. The EIS should include discussion of the action and impacts if reclamation should prove to be impossible.

p. 1. First paragraph of Section B will need to be rewritten by the time the final comes out. Five year permits.

It is not shown which 1844 acres are to be permitted.

p. 4. The boundary shown for area A in Figure 3 is rather strange. The coal outcrop line of Figure 2?

p. 6. What is the maximum expected production?

p. 7. Figure 4. It appears that there are narrow corridors of land betwen ownerships. Who owns these? Why not put ownership on a Screened base of section lines? Township and range numbers should be included. There is a very cryptic note about ash pond development, 1st and 2nd stage. What is that? Several areas do not have any indication of ownership.

p. 6. There is no description of or reference to a description of the coal seams; overburden, thickness, interburden. Is the 74 market analysis of the McKay coal still valid? What/where is coal quality?

p. 9. After coal exposure, the coal seam is drilled, blasted and loaded with a shovel into 120 ton haulers.

p. 14. Climate -- Occasionally, extremely intense storms occur.

p. 23. The severe weather section is not related to the Colstrip area and is basically irrelevant as presented.

p. 24-5. The monitoring stations are named in the text and numbered on the maps, thus preventing any understanding or correlation.

p. 24. There is no indication of why pollutant levels are what they are, no correlation with prior baseline conditions, no indication of sources of pollutants. In short, there is no way of determining the meaning of the data presented or of determining possible future trends.

p. 35. Seismicity -- This has little applicability to the Colstrip area. There is no indication of frequency of quakes. What is Zone 1?

p. 48. Figure 16. It is nearly impossible to locate the cross sections on the location map and to locate the location map in the vicinity.

p. 51. Figure 17. What are the big letters ABC on the map?

p. 50. The water quality section needs a clear understandable, non-technical summary of what it all means.

p. 56. How is total water use distributed through the year? See letter from F & 6 Appendix E-5.

p. 59. How can 13 types be equated to 27 types? This sounds like an impossibility. No maps!

p. 76. Fish were planted in coal pits.

P. 79-89. This section is poorly written and not clear. How reliable are the data?

p. 96. The section is completely inadequate. It does not even clearly show, much less discuss, the different land uses and their interrelations. The map is very poorly constructed. The tables have almost nothing to do with the area of interst unless used for comparison, which they are not. The agricultural lands are not discussed in sufficient detail. Are they irrigated, dryland, subirrigated, crops, hay, or range? The use mao doesn't correspond to the ownership map. What kinds of arrangements for use of lease of land exist? What are the potential land uses, particularly agriculture? Is the townsite sufficient for the expected population? Is there sufficient commerical land available? Is there any possibility of other industries moving in to take advantage of the energy or raw materials available?

What are the relationships among land uses? Are there problems with the town and trailer park located so near the power plant? Will mining disrupt critical portions of neighboring ranches? How are the neighboring farms and ranches arranged? How does the Colstrip area relate to surrounding towns?

p. 100. Has growth declined in terms of rate or absolute numbers?

p. 100-103. The social section notes, but does not use a wealth of data available. Confining the disucssion to generalities is inexcusable, given the amount, both absolute and relative, of study which has been done on this area. The discussion is good as far as it goes, but it could and should be greatly extended and expanded.

p. 105. I would assume that the watersystem is new. Is it? What is the capacity of the distribution system? What is the water pressure?

p. 106. When is the oxidation ditch going to be built? What will the system capacity be then? What is the population of Colstrip?

p. 104. What is the funding situation for public services? Who is paying? How will new facilities be funded? Will Colstrip incorporate? This section is generally good.

p. 113. Are the Lame Deer water and sewer systems adequate? Good condition? Are schools adequate?

p. 114. What are the current water demands and sewage flows in Ashland?

p. 124. There is no consideration of existing traffic with standards. Road improvements are not considered.

p. 132-3. Who did the site ratings? Lahren or DSL? Did Lahren review the ranking?

p. 144. There is a large discrepancy between the climate section data on air quality (p. 24-31) and this section. Are standards being violated or not?

p. 157. Why were sound measurements not taken?

p. 167. What effect will mining have on agricultural employment?

p. 168. What effect will mining have on manufacturing employment?

p. 170. The purpose of the EIS is to analyze the proposed action. If there would be no employment change, then say it. Don't try to scare people with loss of jobs and revenue.

p. 183. This is great!

p. 185. The discussion of the boom and bust cycle of AF-2 is gibberish. What is neutralization? Large expansions of what would be precluded? It sounds like it is being stated that because the boom will be so short, there will be no impacts. If so, it is totally false. Impacts are created by rapid changes in rates of change. The situation described is precisely that of high impact.

p. 187-0. Rather than merely present the expected numbers, they should be directly compared with capacities, and existing numbers.

p. 190. The cumulative environmental impacts section does not address the stated purpose.

p. 192,4. Given the previous statement that reclamation is not assured (p. 161, for example), it is inappropriate to assume here that lands may be returned to former or new uses.

p. 217. Recreation, to be meaningful, must also be considered on more than a site specific basis.

p. 229. Land use -- This paragraph completely begs the question. The issue, it seems, is whether land can be brought to it's former productivity (reclaimed). Can it? Aesthetics, strike the word "needed" in the first sentence.

p. 237. Solar, geothermal and wind converters are not still experimental or pilot scale. Hundreds of companies are selling equipment and have been for years. These are not necessarily scaled to produce power in the quantities generated by coal fired power plants, but that is essentially irrelevant. The technology exists, works, and is competitive in nearly every area of the country. It is and could produce substantial savings in electricity demands.

Table 7 Appendix E-4. Maps of roads should be provided

United States Department of the Interior
BUREAU OF INDIAN AFFAIRS
BILLINGS AREA OFFICE
316 NORTH 26TH ST.
BILLINGS, MONTANA 59101

IN REPLY REFER TO:
Environmental Quality

JUL 18 1977

Mr. Brace Hayden
Department of State Lands
Capitol Station
1625 11th Avenue
Helena, Montana 59601

Dear Mr. Hayden:

This office has reviewed the draft environmental statement for the "Proposed Expansion of Western Energy Company's Rosebud Mine into Areas A and E", and wish to submit the following comments:

1. Page 24, Air Quality. The text states that the discussion of air quality is limited to those air quality parameters directly affected by implementation of the proposed action. In this instance the proposed action would be mine expansion. Regardless of the above parameters, it is believed that the status of the Northern Cheyenne Tribe's request for redesignation of air quality from a Class II standard to a Class I standard would be appropriate.

As you are aware, the power plant may be subject to review under the Prevention of Significant Deterioration Regulations. Under this review the mines are considered as a source of pollutants to be assessed with those of the power plant. It is stated in the text in several instances that the present mine has violated particulate standards on several occasions. The addition of mine generated pollutants to those of the power plant may have significant effects upon the air quality of the Northern Cheyenne Indian Reservation.

2. Page 35. "The Rosebud seam, ... has a thickness of 1725 feet... (Underlining supplied).

3. Page 74, last paragraph. Perognathusfasciatus should read Perognathus fasciatus.

4. Page 99, Table 31. The meaning of the asterisk for Northern Cheyenne acreages should be given.

5. Page 109, Police Department. This section states that the Sheriff's office has jurisdiction over all the area in the County. In respect to Indian lands this statement should be modified to reflect that the Sheriff's Office jurisdiction on Indian lands is determined by the nature of the offense.

6. Page 118, first paragraph. "The two 6 x 5 trucks....", should read 6 x 6....

We appreciate the opportunity to have provided comments on this draft environmental statement. If clarification or further information is required please feel free to call upon us.

Sincerely yours,

Assistant Area Director

CUMIN
MOUNTAIN WEST

SUBJECT: Response to Rosebud Mine's Area A and E Expansion Socio-Economic EIS Reviewer's Comments.

TO: Brace Hayden, Environmental Administrator, Montana Department of State Lands, Helena, Montana.

FROM: Cumin Associates/Mountain West
Consultant Team

DATE: August 5, 1977

1) Brunner: pp. 79-89

The section appears clear, and without definitive questions, specific responses cannot be made. Sources are provided for all data, most of which is from the Bureau of the Census which is reliable.

2) Brunner: p. 96

Figure 19 clearly shows the relationship of the various land uses adjacent to Colstrip and the two mining areas; the map is a scaled drawing with both the Colstrip Community and the total mining areas clearly shown for reference. The vacant land category refers to rangeland only while the agricultural category refers to lands currently being dryland farmed; there are no irrigated, sub-irrigated, or hay agricultural lands in the area shown in Figure 19 or they would have been thus delineated. The land use map shown in the EIS is the first time land use in the area has been graphically depicted even though the Colstrip vicinity has been the subject of several EIS's which should have made some attempt at mapping land use. Since this EIS concerned the continuation of an on-going level of mining activity, it was not the intent of the EIS to initiate a data base from tabula rasa, and Figure 19 is a 100 percent improvement over the land use data base previously existing.

The reviewer is perhaps confused when he states, "The use map doesn't correspond to the ownership map." Of course it does not. It is not clear what this reviewer means by, "-use of lease of land'." Western Energy Company's policy in the lease areas is to maintain as much of the agricultural base operations as possible, and, therefore, farming and ranching agricultural operations continue in the lease areas up to the time of actual mining. Only about a quarter of a quarter section (Section 30) of mining Area A is presently a part of an adjacent ranch, and this land is currently being negotiated between the landowners and the mining company (Michael R. Grende, communication, August 5, 1977.)

As to the potential land uses - particularly agriculture, the question is vague. Is the reviewer referring to mined areas - and before or after mining - or to areas not planned for mining? As the Colstrip Community grows the potential land uses are as varied as the uses usually occurring in a small city, from transportation to neighborhood commercial activities. For a discussion of the potential for area agriculture lands, reviewers are referred to the 1975 Situation State. Rosebud and Treasure Counties, U.S.D.A. Committee for Rural Development. Post mining area lands will probably be returned to rangeland if located beyond the influence area of community land uses; the potential for such is discussed elsewhere in the EIS.

The townsite is sufficient for the "expected" population as no population increase is expected with continuation of the existing level of mining activity; there is also sufficient commercial land available for the expected population on the same basis. There is a possibility of other industries moving into the area.

The question about the relationship of land uses is not definitive enough. As it relates to the scope of the EIS, it is answered, but the issue concerning the relationship of the existing town and trailer park to the power plant and the arrangement of neighboring ranches are not within the scope of this EIS; the same applies to reviewer's desire for a discussion of the relationship of Colstrip to the surrounding towns - the land use under study was that in mining Areas A and E and its relation to the surrounding vicinity.

3) BIA: p. 99

The asterisk refers to the Note at the bottom of the table.

4) Brunner: p. 100

Growth has declined, both in rate and absolute numbers, although this is not substantiated because of a lack of a 1977 census and is, rather, the feeling of the County Planning Coordinator.

5) Brunner: pp. 100-103

It is not agreed that the mass of social data referenced here should be reiterated *in toto* in the EIS. As the existing information relates to the overall coal development activities, it is clearly referenced, and none of the information specifically responds to the very limited activity addressed by the EIS.

6) Walthall (?): Social Structure

After defining social structure to his satisfaction, this reviewer states the importance of describing the manner in which large numbers of workers affect the way locals are and have traditionally interacted; this is beyond the scope of this specific EIS as no large numbers of workers will come into the area with continuation of mining in Areas A and E.

7) Walthall (?): Social Structure: p. 102

The comment states that what is described as the conservative nature of the local people is not related as to its implications; whereas, the remainder of the paragraph points out that such a characteristic shapes their attitudes towards strip mining, i.e., "-acceptance of a land ethic philosophy, distaste of aesthetic values destroyed or sullied, and the impatience with the length of time required to recreate naturalistic environments once land has been strip mined."

The reference for Number 8 is "How Montanans View America," by K. Ross Toole, Montana Business Quarterly, Spring 1975, Volume 13, #2; Bureau of Business and Economic Research, University of Montana, Missoula, Montana. The reviewer disagrees that locals feel alienated by "eastern" interests and policies of BLM but rather feels that the "dishonesty and deceit-" of - federal - as well as private corporations is the issue. The reviewer seems to agree with what he is disagreeing with, although "eastern" interest must be taken broadly to include the general American industrial complex influence.

There is no study now, nor has there been one, which shows "what life is like for both locals and newcomers." The ethnographic research of Gold does not lay claim to such a broad examination nor does the statistical analyses of Jobes.

As pointed out in the EIS, the process of social change has already started and subsequent societal analysis is limited by having to deal with a social structure already in relatively rapid transition. Futher, as indicated in the EIS, the continuation of on-going levels of mining activity in areas of A and E will not produce social impact.

8) Brunner: p. 104

To take each of the public services and facilities in each of the local governmental units and indicate the cost and the various methods financing each would entail an extensive amount of research; usually there are more than one source of funds being used too, for example, pay for the county law enforcement program. Such research is beyong the scope of an EIS where the major focus of the EIS is an assessment of an on-going level of mining activity. Sources of funds which have helped mitigate the adverse impacts of coal industrialization in the area are discussed on Pages 210-215 of the EIS. The method of funding new facilities is usually determined on an ad hoc basis. It is not known if Colstrip will incorporate.

9) Brunner: p. 105

Assuming the reviewer is referring to p. 104, the water system is not new; the original system is about 20 years old with additions being made at various times over the last two decades. For general purposes, without getting into such specifics as fire flow requirements in the commercial areas, the capacity of the Colstrip water system is about 5000 people. The water pressure ranges from 35 to 60 pounds per square inch. (Jerry Gaston, P.E., Sanderson, Stewart, Mueller Engineering, Inc., Billings, Montana; inverview, August 4, 1977.)

10) Brunner: p. 106

The oxidation ditch should be completed by July 1978 and will have a capacity of about 600,000 gallons per day (Gaston, op cit.). The population of Colstrip (July 1977) is approximately 1730 (Rosebud County Comprehensive Plan, unpublished data).

11) Brunner: p. 113

With the exception of water supply, the Lame Deer water system is adequate for existing population; an additional well will rectify the existing slight inadequacy in supply. The Lame Deer sewer collection system is adequate for the existing population; however, the surface area provided by the lagoon treatment system is not sufficient given the existing population level. The school district is currently planning a new high school in the vicinity of the existing sewage treatment area which will necessitate moving the lagoon; funding for the school has not yet been obatained (Lloyd Stien, Engineering Division, U.S. Bureau of Indian Affairs, and Mark Werre, Indian Health Service, U.S. Department of Health, Education and Welfare, Billings, Montana, communications, August 4, 1977).

The Lame Deer school provides adequate classooms and related facilities for about 415 students in grades kindergarten through eighth (see Appendix E-3). The community would like to build a high school in the town in order that the busing of high school students to Colstrip, St. Labre, and Busby schools could be stopped (Phyllis Big Left Hand, Federal Project Coordinator, Lame Deer School, communication, August 4, 1977).

12) Brunner: p. 114

The current water demand in Ashland is 97,500 gallons based on a served population of 390 and a water use standard of 250 gallons per capita day; the system has a design capacity of 1200 population. Using an effluent generation standard of 100 gallons per capita day, the Ashland Community generates a daily sewage flow of 39,000 gallons; the sewage treatment system has a design capacity of about 630 people (Jerry Gaston, op. cit.).

13) Brunner: p. 124

It is not clear exactly what is desired with this comment. Without a detailed traffic loading analysis of the roadways in the Colstrip area - which is beyond the intent of this EIS - the loading capacities at the various theoretical design levels of service - which would vary per segment of roadway - cannot be determined. A general indication of loading at a service level of C for a paved two-lane road according to the Highway Capacity Manual (Highway Research Board, Special Report 87, 1972 amended, p. 42) is about 1500 cars per hour in either direction. Planned roadway improvements in the immediate Colstrip area are discussed on Pages 216 and 217 and in Table 1, Appendix E-4 of the EIS.

14) Brunner: pp. 132-133

The rankings were made by Dr. Larry Leondorf.

15) Brunner: p. 167

Granting of a permit will allow present mining activities to continue at existing employment levels. Therefore, no new jobs will be created which might draw laborers from the agricultural sector. The construction of Colstrip 3 and 4 will create new mining jobs but Colstrip 3 and 4 are not contingent upon this mining permit.

16) Brunner: p. 168

There are not many manufacturing jobs in the area now. Granting a mining permit and maintaining mining employment at present levels will not affect manufacturing.

17) Brunner: p. 170

The issue is not that there would be no employment change. Not issuing the permit would result in the loss of existing jobs, and this has an impact. It is that impact which is discussed. There was no intent to scare anyone.

18) Brunner: p. 185

AF2 describes the situation assuming the construction of Colstrip 3 and 4 and the rapid and the large population increases referred to are associated with the Colstrip 3 and 4 activities. It was necessary to look at total effects in order to try to define the effects of mining alone. Granting a permit resulting in mining continuing at present levels will have no employment or population impacts. We agree that nuetralization is not a good word in this context. In this case it was intended to show that at certain population levels, demands and services available would be in balance. Precluding expansion of services due to rapid population decrease refers only to large permanent facilities. It does not refer to establishing temporary service facilities to meet the needs of a temporary population.

19) Brunner: pp. 180-187

Throughout the socio-economic portion of the EIS, much more information has been generated than that specifically required to assess what is, basically, the continuation of an existing level of mining activity at the most. Given this understanding, it is not felt comparing expected populations to existing or expected capacities is useful.

20) Brunner: p. 190

To be answered, this criticism would have to be more specific, and, from a socio-economic viewpoint, the cumulative impact section completely fulfills its purpose.

21) Brunner: p. 217

Recreation is considered in the EIS on a regional basis (see pp. 125-126 and Appendix E-6).

22) Brunner: p. 229

The question of the issue of reclamation is addressed elsewhere in the EIS.

23) Brunner: Table 7

See Item 19.

24) Responses to Dwayne Ward's Comments:

Paragraph 1: We agree that some relative measure of the various industries in the county is useful. However we feel that showing the different sectors by percent of the county total is a better indicator than location quotients. (See Tables 24, 25 and 29.)

Paragraph 2: We have attached some changes and corrections on this portion of the analysis appearing in the EIS which might help clarify some of the reading difficulties.

P. 167: We agree; part of the agricultural section could be placed in the existing environment section.

PP. 168 and 169: The gradual increase in the wood products industry is based on conversations with the County Planner who had heard of the proposed activities.

P. 170: From this page on, some changes and corrections have been made on the attached sheets which should clear up some of the confusion.

P. 170: The Alternative Futures and Scenarios analyzed are defined as follows:

- -AF1 assumes no Colstrip 3 and 4.
- -AF2 assumes construction of Colstrip 3 and 4
- -S1 assumes no mining permit and no Colstrip 3 and 4
- -S2 assumes no mining permit and Colstrip 3 and 4

P. 171, Second Paragraph: This refers to the employment loss discussed on Page 170 (150 mining jobs) and relating that to Tables 40 and 41. "Previous two tables" refers to Tables 40 and 41.

P. 171, Bottom: Such a scenario might be run. We, however, assumed that additional coal production would occur in Montana.

P. 173: Tables 42 and 43 - The table titles should read:

Table 42
Scenario 1
Employment Change Associated With Permit Denial Without Colstrip 3 and 4 - 1975-1985

Table 43
Scenario 2
Employment Change Associated With Permit Denial With Colstrip 3 and 4 - 1975-1985

The employment change is from estimates if the permits are approved. However, it should be noted that the 150 mining jobs lost under Scenario 1 and 150 of those lost under Scenario 2 are existing jobs.

P. 174: Operating people are included.

P. 176: Some of the Alternative Futures and Scenarios designations were mislabeled both on Page 176 and in Figure 22. These have been corrected in the rewrite.

P. 176: Construction on Colstrip 1 and 2 stopped in 1977. The intent here was to say prior to 1978. It should be corrected to 1977.

P. 178, Second Paragraph: It is between various scenarios.

P. 181: Figure 26 should have been on Page 183.

P. 181, Northern Cheyenne Employment: Because there was not time in this EIS to do fieldwork, it was not possible to check the Northern Cheyenne participation in mining. The number 27 may be high. It was based on historical entry factors in the different sectors and on assumed changes in mining participation by the Northern Cheyennes. If it is incorrect, the overstated portion can be reallocated to the Anglo population. The total number is still correct.

P. 178, Graph: There is graph on Page 178. If Figure 23 is being referred to, the top Anglo line should be labeled just AF2 and the lower Anglo line should be labeled just S2.

Section VI: True, the economic return of mining an area of land could be compared to the economic return of agricultural production making whatever adjustments are necessary concerning productivity levels of reclaimed land. Doing it for a relatively small land area, such as Areas A and E, will probably show a significantly greater return for mining. Production on reclaimed land would also have to be considered with this return being part of the return allocated to the land which is mined.

25) Consultant Clarifications Related to the Socio-Economic Portion of the Draft EIS.

In reviewing the Draft EIS, it became apparent that there was some confusion concerning the use of Alternative Futures and Scenarios and how they related to one another. Copies of Pages 170-184 of the Draft EIS are enclosed with corrections to the text written in.

Key points relating to Alternative Futures and Scenarios are:

AF1 assumes no Colstrip 3 and 4
AF2 assumes construction of Colstrip 3 and 4
S1 assumes no mining permit and no Colstrip 3 and 4
S2 assumes no mining permit and Colstrip 3 and 4

Implicit in AF1 is that mining in Areas A and E will continue (a permit is issued) and under AF2 mining in Areas A and E will also continue but at a faster rate (a permit is issued).

To define the employment, population, and income impacts of not issuing a permit if Colstrip 3 and 4 are not built, one must compare AF1 against S1 since AF1 assumes no Colstrip 3 and 4 with a mining permit while S1 assumes no Colstrip 3 and 4 without a permit.

To determine the employment, population, and income impacts of not issuing a permit if Colstrip 3 and 4 are built, one must compare AF2 against S2 since AF2 assumes Colstrip 3 and 4 with a mining permit while S2 assumes Colstrip 3 and 4 without a permit.

The whole Colstrip 3 and 4 issue had to be raised here because the effect of not issuing the mining permit varied under the with and without Colstrip 3 and 4 cases. It is important, however, that the total Colstrip 3 and 4 impacts not be confused with the mining permit impacts. Denial of the permit will result in presently existing mining jobs being lost along with some secondary jobs resulting from those mining jobs.

Granting of the permit will maintain the existing jobs. If Colstrip 3 and 4 are built, additional mining jobs will be created, and these jobs could occur in Areas A and E if the permit is granted and if A and E are the areas where increased production occurs. Under AF2, it is assumed that production increases and employment increases do occur in Areas A and E. Therefore, lack of a permit (S2) would result in loosing existing jobs plus loss of the future potential jobs required to increase production. It should be noted, however, that the incremental mining jobs created under AF2 are a result of Colstrip 3 and 4 and not of issuing the mining permit.

It is difficult to assess the impacts of the new mining jobs if Colstrip 3 and 4 are built because those jobs might occur outside of Areas A and E. For illustrative purposes it has been assumed in this case (AFS S2) that those jobs would occur in the A and E areas and the impacts in the area resulting from them have been defined.

United States Department of the Interior

GEOLOGICAL SURVEY
United States Geologic Survey
Northern Powder River Basin Environmental Statement Team
Post Office Box 1135
Billings, MT 59103

Agusut 4, 1977

Mr Brace Hayden
Environmental Coordinator
Department of State Lands
Captial Station
Helena, MT 59601

Dear Mr. Hayden:

As you know this team is in the process of developing the Regional Environmental Statement and Sites Specific Environmental Statements, which also include the lands, proposals, and impacts as in your draft environmental impact statement, for Western Energy Company's (WECO), Rosebud Mine expansion areas A and E. Our work in this area is not complete at this time. However, a review of your statement developed the following comments:

Page 35, 1st paragraph, 3rd line. The Rosebud Coal seam is not 1725 feet thick.

Figure 17, Does not show the location of Area E.

Page 50, paragraph 1. Work by Rhon and others is not consistent with this paragraph.

Page 56, paragraph 1. It is doubtful that, "Inhabitants rely on locally impounded surface water for domestic....use".

Page 60, Table 18. This tables presentation of acres effected and disturbance levels more correctly belongs in Chapter 3, Impacts.

It would help the reader if a map of vegetative type with the boundary of the proposed disturbance areas superimposed on it was included.

Page 67, Paragraph 4. Yields are predicted for wheat, but no predictions are made for alfalfa. There is no discussion of whether this is irrigated or non-irrigated.

Page 72, Wildlife. There is a need for clarification of the importance of Big Sage and Silver Sage to antelope. Discussion indicates a preference for Big Sage, (Page 72), and heavy use of Silver Sage in diet, (Page 74).

Habitat utilization by Sharptail grouse, Ring-necked pheasant, and other upland game birds should be summarized. Critical habitats for upland game birds in and near Areas A and E should be identified.

Waterfowl use of the East Fork of Armell's Creek, Page 73, should be elaborated upon, (nesting, migration stop site, molting site, staging area, etc.).

The comment pertaining to the area of disturbance around Colstrip, (Page 73), if quantified, should be expressed.

"Productivity indicies, ...Pronghorn antelope", (Page 73), Parturation sites should be identified on a map or described narratively. References for other information should be cited or data appended in Volume 2.

Big game association with habitat type should be summarized and the critical habitats of and near Areas A and E should be identified. This should include a discussion of the loss of habitat and displacement of wildlife into adjacent types.

The non-game wildlife discussion is very limited and should be expanded to discuss critical habitats of Areas A and E and adjacent areas for non-game wildlife, (raptor nesting and hunting sites; small mammal densities, species diversity, and distribution; critical sites for endangered, threatened and unique species).

Page 75. Describe in which ways existing data gaps prevent adequate description of environments for wildlife in Areas A and E.

Page 79, Population. It would be useful to give some impression of the surrounding counties' population in addition to that given for Rosebud County. There is a need for a statement on population adjustment (boom-bust) to be made in reference to the construction slowdown after Colstrip I and 2 were completed.

Page 82, Employment. A better portrayal of the agricultural sector in rural employment might be useful. There should be some discussion about the general employment in southeast Montana, not just Rosebud County, this could express how dependent services in wholesale and retail trade are upon agriculture. Location quotients of employment would be useful for this. There is a need for a 1976 employment figure for mining. It would be useful to comment on the fact that manufacturing cannot be looked upon exactly the same as it can be in the industrial portions of the United States. Emphasis should be on rural employment.

Page 90, Income. The outdated nature of the income data used is a problem. The narrative should allude to the fact that Western Energy Company and Peabody Coal Company are, in fact, new income generators in the region. Some reference should be made about capital expenditure in the area by these existing mining companies. Again, some reference needs to be made about the dependence on agricultural income in the area.

Page 96, Land Use. This section should identify the land uses within the areas, and if necessary could show a cross reference to discussions in Social Services, Transportation, etc. This section should include, if they are present, a discussion on powerlines, communications lines, reservoirs, wells, access roads, etc. This section should also include any present and/or abandoned improvements. Are there any authorized or unauthorized uses including conflicting land uses? What are the recreation land uses? This section is not explicit about the land uses which are occurring in Areas A and E. It would help if a quantification of the types of land uses within the mining area boundary was included so the reader could tell what will be altered and what will be impacted.

Figure 19. A definition of the land use category of "vacant" is needed.

Page 100, Social Structure. There is some questioning of the Jobes and Parsons socio-economic study of southeastern Montana as pertains to their evaluation of this region. It might help to have a full understanding of the madeup of the rural way of life, its history and cultural background. Is the way of life in southeastern Montana different from that in parts of Dakota, Wyoming, and perhaps other rural areas? The portrayal of the "rancher" as one who is totally in "love with the land" is questionable. Toole's book, (Page 78-79), differs with some of the work that has been done at the Institute for Social Science Research, University of Montana, NGP Resources Program. Are the land holders' attitudes, opinion, and reactions so different from other groups that are involved in change?

The concept of new urbanization may be misleading. The term, rural concentration might be a more adequate term, because these concentrations are certainly not the same as concentrations in the industrial portions of the United States.

Page 101, Paragraph 3. The quote, "As urbanization occurs, residents become less oriented towards other individuals in the community and more oriented towards institutions and extra community forces", is too abstract. It would appear more fair to say that portions of the country or region will see changes, with new people and new purchasing power. More commuting will occur, and life may have a faster pace. It is not yet evident that the sociologists can apply urban concepts to such a rural area that has been engulfed by new people. Perhaps, the real outcome is that a blending of "ways of life" occur.

Page 108, second paragraph. The city of Forsyth is probably taking about five cubic feet per second of water rather than fifty cubic feet per second.

Page 121, Paragraph 2, Line 10. Nichols is mis-spelled.

Page 129, Figure 20. The directional orientation of this map is not shown.

Page 149, Overburden. In Chapter 2, the uptake of molybdnum and zinc was alluded to. What are the impacts?

Page 158, Biological Environment. There is no reference to vegetative concentrations of essential elements to toxic levels; or reduction in levels of dietary elements.

Page 163, Wildlife and Aquatic Environments. There is a need to describe the area of disturbance around the mining site. Habitat types loss should be quantified. This could be obtained from a vegetative type map of the area.

The treatis is very general in identifying critical areas impacted or lost because of the mining areas, and those areas receiving displaced animals from these mined areas. What are the impacts on food sources; raptors-small animals, vegetative foods-toxic levels or submaintenance levels of dietary elements?

Page 167, Agriculture. Will agricultural employment continue to decline? It probably will not decline at the rate it has been declining.

Page 170, Paragraph 2. Are the figures correct for usage of coal for Colstrip 3 and 4? Out understanding was that Colstrip 3 and 4 would use approximately 6 million tons per year.
5.5 combined

Page 192, Land Use. Based on our previous discussion concerning those items that we feel should be included in Land Use, this seciton may or may not be correct in its discussion that the only change, is the intrusion of mining upon unmined land which is presently range. This general statement should be quantified, for example showing rangeland removed from production.

Page 193, Transportation. The only impact discussed is on roads, and only one road is identified, I-94. There should be a clear statement of what the impacts are. There needs to be a statement discussing impacts of increased rail traffic. There is no discussion of the impacts on air traffic.

Page 196, Aesthic Values. This chapter does not relate well to the discussion in Chapter 2.

Page 201, Noise. There is no discussion of this item "Noise" in Chapter 2. In order to discuss an item under mitigation, it should be discussed in Chapter 2's description of the existing environment.

Page 203, Paragraph 2. The statement is made that the area should be reclaimed to a state where it does not require intensive livestock management. The mined areas should be intensively managed, at least for the short-term after reclamation, so that they may be able to withstand grazing in the longer term without intensive management.

Page 204, Paragraph 3. It is unclear as to what is being brought forward as a mitigating measure in this paragraph.

Page 207, Wildlife and Aquatic Environment. The discussion of reclamation, and its limitations in the vegetation section, indicates re-establishment of vegetative communities, (diversity and types), important to wildlife is questionable. This section proposes as mitigation for wildlife the re-establishment of such communities? These two sections appear to be in conflict. Reclamation that benefits multiple use, rather than limited use interests (livestock and agriculture), to the highest level that current technology allows should be proposed. This should include stock pile separation of topsoil horizons in order to allow a re-establishment of these strata.

Irreplaceable critical features such as sandstone cliffs, ponderosa pine stands, and rugged relief, might reasonably be left in place as mitigation.

Relative to increasing human disturbance, limited access to mine related roads, where possible, might be addressed.

The mining companies should be responsible for continuous reclamation research and the monitoring of reclamation, and wildlife use of reclaimed sites, throughout the duration of the lease.

Page 210, Human Environment. Where are the mitigating measures for land uses? The land uses identified in previous chapters seams to be dropped at this point and not addressed in this or subsequent chapters.

Page 222, Biological Environment. Clarification of the second paragraph is needed. What wildlife habitat dependent upon what unusual conditions or diversity, could be permanently lost? The first sentence in this paragraph is also unclear, or at least this sentence should be expanded upon. The current state of the art of reclamation indicates that sagebrush, ponderosa pine, juniper, etc. are difficult to re-establish.

Rugges relief will not be re-established, which has a definite detrimental effect on wildlife.

There is need for discussion concerning the loss of leks and limited success in their re-establishment. E.C.S. has been doing research on relocation of grouse leks.

Page 224, Short-term Use vs. Long-term Productivity. This section is unclear and shallow in its definition and discussion.

Page 228, Biological Environment. Establishment of native conditions of western range has occurred over a long tern, subject to climate, soil conditions, and other variables, To re-establish these same conditions will require another long-term process of inner-actions. Some capabilities of the environment to reproduce native conditions may be permanently lost. Native wildlife will have to adapt to the existing environment or be replaced by species adaptable to the available niches.

Pages 236, Paragraph 2. The statement that, "Much of the state's water resources would be completely lost", is questionable. A minute portion of the overall water supply would be used, and this could be stored during peak run-off periods.

Page 236, Paragraph 3. The statement, "No markets for slurry are currently available", is questionable. Slurry lines are currently in operation, and markets would develop with the advent of new slurry pipelines. There is also the potential for return lines one-half the size of the slurry line to return the water to the slurry plant. The only water loss would be that needed for a small amount of recharge.

The relevance of the discussion concerning the pros and cons of the in situ mining in this report is questionable. The expansion area does not lend itself to in situ mining.

Volume 2, Appendixes. The appendixes should be page numbered and a table of contents included for Volume 2.

In a general vein, it appears that throughout this Environmental Statement, there are lengthy descriptions and discussions of situations that are not relevant to the expansion area. The Cultural Resources section is weak.

Sincerely,

Glenn Malmberg

Glenn T. Malmberg
Task Force Leader

GTM/sm

cc: Ernie Kemmis
Joe Elliot
Bob Pizel

REPLY OF OLSON-ELLIOTT & ASSOCIATES TO COMMENTS FROM GLEN MALMBERG , U.S.G.S

Page 60, Table 16: This table describes the acreage of existing communities in the areas to be affected and is directly related to the description of the area. Duplicating the information in a second table with the impact's section was not done in the interest of economy of space.

Vegetation maps were inadvertently omitted from the Statement and are now included.

Page 67, Paragraph 4: Wheat yields were not predicted, only historical information described. Alfalfa data on area A is included in the Appendix. Alfalfa hay yielded 1.2-1.9 tons per acre and alfalfa-oats hay averaged .95 tons per acre during the years for which data was presented.

Page 72, Wildlife. The importance of big sage and silver sage are described in the report with reference to the available information on the animals in the area. The reference on page 72 refers to correlation data of observations versus habitat types. A distinct preference for big sage only was determined using this data base. Observations of food preference from a separate data base indicated that silver sage was very important during the winter months (page 74). Obviously, both types are important. More details on the available data concerning the importance of the habitat types can be obtained by referring to the cited publications.

Habitat utilization data on sharptail, ring-necked pheasants and other upland game birds was included in the ECS 1975b; 1976b reports. Detailed presentation of all available data on these species is beyond the scope of this impact statement. Critical habitats have not been defined for any of the game species in the areas with perhaps the exception of grouse leks. There are no known grouse leks within the proposed permit areas of A and E. Leks within the Colstrip vicinity are described in the cited references.

Waterfowl use along the East Fork of Armell's Creek is described in more detail in the cited references (ECS 1975b; 1976b). As Armell's Creek is not directly affected by the area A and E developments, detailed consideration was not deemed appropriate.

The area of disturbance around Colstrip is the apparent trend observed in frequency of observation data as a function of the distance from Colstrip, depicted in ECS, 1976b. Mathematical analysis of the "apparent" trend has not been performed.

The references for the data are all cited. Data bibliographies for all studies in the region are beyond the scope of this EIS. No parturition sites occur within the proposed permit areas.

Big game association with habitat types is described, page 72. More detailed data is available in the cited references. Critical habitats for big game species have not been clearly defined. Habitat loss is discussed in the impacts section.

Critical habitats for non-game wildlife species have not been clearly defined. No known raptor nesting sites occur on areas A and E. There are no known rare, endangered or unique species. Available data for small mammals and other non-game species are listed in the references cited (ECS, 1975b; Lewis,Morton and James, 1976). Little data are available addressing raptor hunting sites, small mammal densities or species diversity.

Page 75: The lack of data may be more revealing of the lack of use of the areas by wildlife species than indicative of an inadequacy of effort. However, negative data (Amount of effort expended without positive observations, etc.) would be more valuable in determining actual wildlife trends. Potential wildlife habitat (excluding behavioral affects) can be described adequately using the vegetative data in most instances.

Page 158: Detailed discussions of nutrients and toxic substances are included in the mitigation sections, page 206. This is a problem of reclamation in the process of mitigating impacts caused by the mining activity.

Page 163: The vegetative component of wildlife habitats can be considered in the vegetation acreage summary presented in Table 18, page 60. All of the vegetation types on areas A and E are used by wildlife species during some season. The term "critical" as described earlier has not been clearly defined. Certainly, the population of the species in the area will be reduced with the reduction of the wildlife habitat, although no populations should be eliminated. Displacement of animals is not realistic as habitats in the area should already be used by available species, unless population cycles are low or behavioral affects occur. The elimination of the habitat should in the long term, eliminate that number of animals previously supported by the habitat. The success of reclamation will ultimately determine the long term impact of the wildlife populations in the area.

Page 203, Paragraph 2: It is assumed that intensive management means severely regulating livestock use on the areas until sustained use can be maintained. This should be required to insure proper reclamation.

Page 204, Paragraph 3. It is suggested that more intensive reclamation practices may be required if the present reclamation law standards are to be met.

Page 207: As pointed out, there appears to be difficulty in reestablishing species important to wildlife on reclaimed plots. Further research is suggested as a method to determine successful reclamation techniques and the type of seed beds and soil strata that need to be reestablished on reclaimed lands. If successful reclamation can not be shown for these species which are important to wildlife, exclusion from mining should be another alternative. Terrain features which are not replaceable have not been considered to merit exclusion under current state land department policies.

Limited access on mine-related roads is currently a common practice in the area.

Western Energy is continuing monitoring efforts and reclamation research in the area.

Page 222: Wildlife habitat involves a variety of plant communities and topographical features to provide food for different seasons, cover and habitat features unique to individual species. Reclamation is generally to more uniform vegetation types and the diversity of habitats required for numerous wildlife species, game and non-game, will be lost. It has not yet been determined that such species as Ponderosa pine, juniper, sagebrush will ever again occupy the area, but is is very unlikely that the original diversity will again occur.

There are no grouse leks on areas A and E. Success at reestablishment is not relative to the proposed action since none are directly affected.

Page 228: This statement is true and was discussed in other sections of the EIS.

General Comments Concerning the Remarks by the U.S.G.S. Team.

The Wildlife and Vegetation sections of the EIS addressed those immediate areas to be affected by mining on A and E. Secondary and regional effects were not addressed, nor was there any attempt to include all information available with the EIS, but rather to list appropriate references as to the available descriptive data for the area. This provides some reduction in the increasing bulk which plagues many of the EIS's being completed. The term "critical" with regard to wildlife habitat needs further clarification with regard to the relationship to mining activity. It is suspected that no areas are "critical" for maintenance of some of the population of the game species in the area, but probably all areas are necessary to maintain current or current potential populations of most wildlife species.

CUMIN
MOUNTAIN WEST

SUBJECT: Response to Rosebud Mine's Areas A and E Expansion Socio-Economic EIS Reviewers' Comments (U.S.G.S. - Malmberg)

TO: David Janis, Environmental Coordinator, Montana Department of State Lands, Helena, Montana

DATE: August 22, 1977

Page 79, Population:

More regional information would be interesting but in this case, it was not essential and to provide more information than was presented was precluded by project time constraints.

I assume that the comment on population adjustment refers to the effect of the job loss resulting from not granting the permit. The population, employment, and income effects of the job loss are discussed.

Page 82, Employment:

While the impact analysis of the proposed mining expansion must be considered in a regional analysis, this study was not a regional analysis. An analysis of central places in the region showing the role of agriculture and the increasing role of mining along with labor force trends and migration patterns would be interesting, but it could not be done as part of this study. Mining figures for the mining activities under analysis are provided for 1976.

We are not exactly sure by what is meant in the comment on manufacturing.

Page 90, Income:

WECO and Peabody employment data and the resultant population and income implications of those jobs are used in the analysis. The analysis takes account of the secondary effects of the loss of the jobs caused by denial of the permit. It is unclear what the reviewer refers to by "capital expenditures". The importance of agriculture in the regional economy is shown in the baseline description.

Page 96, Land Use:

Much of these comments is covered in response #2, our comments forwarded DSL, August 5. No purpose would be served by correlating services to the rangeland (Vacant) category which is the only land use involved in the expansion. If the particulars as to haul roads, communication lines, etc. are desired, the details are shown on the exhibits accompanying the request for permit amendment; this includes existing improvements, and there are no abandoned improvements in the expanded mining area. It is not clear what the reviewer means by "authorized or unauthorized uses". There are no conflicting land uses in the expanded mining area other than those generally inherent when rangeland is strip mined. Specific recreation land use is shown in Colstrip on the Land Use Map, and recreation in general is discussed in the text. As to identifying land use in the mining areas, it is rangeland.

Page 100, Social Structure:

It is agreed that a full blown description of the makeup of rural life would be useful; however, it doesn't exist, and the assessment of an on-going level of mining activity is not the project in which to find such a broad analysis. We are looking forward to this regional, multi-state, social study with the completion of the NPRBEIS.

Page 101, Social Structure:

It is debatable which comment is more abstract - the NGPRP statement, or that of Malmberg's.

Page 108:

The City of Forsyth can draw water at the rate of fifty (50) cubic feet per second.

Page 121:

Nichols is correct.

Page 129:

The directional arrow is at the bottom right-hand side of the map.

Page 167, Agriculture:

It is assumed agricultural employment will continue to decline but probably not at the past rate.

Page 170:

Colstrip Units 3 and 4 are projected to consume 5.6 million tons per year.

Page 192, Land Use:

The statement in the EIS is correct; quantification is made on page 1 of the EIS.

Page 193, Transportation:

See response #13, our letter of August 12th. In addition, expansion of the on-going level of mining activity will have no impact on air traffic.

Page 196, Aesthetic Values:

As pointed out in Chapter 2, the major impact is visual, and p. 196 continues this theme.

Page 210, Human Environment:

The mitigative measures applied to the specific impact of changing rangeland to mining area is reclamation which is discussed elsewhere in the EIS.

The last paragraph is brilliant and contradicts the whole thrust of Malmberg's critque! The last sentence is specifically inapposite.

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BOSTON
CHICAGO
CINCINNATI
CRANFORD
DENVER
FAIRBANKS
HONOLULU
HOUSTON
LOS ANGELES
NEW ORLEANS
NEW YORK
PHOENIX
PORTLAND
SALT LAKE CITY
SAN FRANCISCO
SANTA BARBARA
SEATTLE
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WASHINGTON, D.C.
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DAMES & MOORE
CONSULTANTS IN THE ENVIRONMENTAL AND APPLIED EARTH SCIENCES

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1620 ALDERSON AVENUE · BILLINGS, MONTANA 59102 · (406) 248-2641

August 23, 1977

Mr. David Janis
Environmental Coordinator
Department of State Lands
Capitol Station
Helena, MT 59601

Dear Mr. Janis:

This letter contains our responses to the U.S. Geological comments received on the draft environmental impact statement concerning the Western Energy Company's mine expansion in Areas A and E, Colstrip, Montana. Specifically, our responses regard the comments received with you letter dated August 19, 1977, and which pertain to the physical environment sections prepared by Dames & Moore.

Our responses to the comments presented by Mr. Glenn E. Malmberg of the USGS are presented below according to the page number listed in his letter adjacent to that comment.

Page 35: The Rosebud coal seam is 17 to 25 feet thick.

Figure 17: It would be helpful to the reader if the location of Mine Area E were shown on this figure. However, since the figure does not specifically present hydrologic data for Mine Area E, showing its location is not a necessity.

Page 50: We did not have the opportunity to review the work done by Rhon and others. The statement presented in paragraph 1 is based on investigations conducted by the Montana Bureau of Mines and Geology. This was the only data on the hydraulic properties of existing mine spoils in the Colstrip area that we found available. If the work done by Rhon and others pertains to the Colstrip area and is of importance, it should also be mentioned in proper context.

Page 56: We agree it is doubtful that "inhabitants rely on locally impounded surface water for domestic...use". In the Dames & Moore draft sent to the Department of State Lands our sentence read otherwise, as follows: "Outside of Colstrip, inhabitants rely on locally impounded surface water for stock and irrigation needs and upon ground water for domestic and supplemental stock use." Apparently in the editing of our original statement, the wrong connotation was placed into the Department's draft copy.

Page 201: To discuss the item "noise" under the mitigation chapter, it is not absolutely necessary to discuss noise in Chapter 2, Description of the Existing Environment. Mitigation measures are taken to lessen or eliminate adverse impacts. Therefore, a discussion was presented under Chapter 3, Environmental Impacts (page 156 of the report) to which a comparison could be made. The reason baseline noise information was not presented in Chapter 2 is that no site-specific studies have been conducted in the mine and at Colstrip for which this information could be stated.

Page 236: The statements pertaining to water use in this section of the report were prepared by the Montana Department of State Lands.

The above responses address all those comments for which Dames & Moore was responsible in preparing the original draft EIS. If you should have any questions concerning these responses or need further clarification, please do not hesitate to call us.

Sincerely yours,

DAMES & MOORE

Theodore E. Rosengreen

Theodore E. Rosengreen, Ph.D.
Project Manager

db

STATE OF MONTANA

DEPARTMENT OF
FISH AND GAME

P.O. Box 430
Miles City, MT. 59301
June 21, 1977

Environmental Coordinator
Department of State Lands
Capitol Station
Helena, MT. 59601

Gentlemen:

Generally speaking, the wildlife data presented in the Draft EIS for the proposed expansion of Western Energy Company's Rosebud Mine into areas A and E is satisfactory. However, I would like to take exception to several of the proposed mitigating measures (pages 207-209) and suggest one other possible measure.

It is my impression that the burden of mitigation should fall in its entirety on the party initiating the action. But it appears to me (page 208) that you are suggesting more intensive wildlife management be used as a mitigating measure on and/or near the impact area. Is this not an attempt to shift a portion of the burden to someone (Montana Department of Fish and Game) other than Western Energy Company?

The fact that (as you state) much of the wildlife habitat to be destroyed can probably not be replaced is an admission in itself that requirements of the 1973 Strip Mining and Reclamation Act cannot be met. In light of this, it seems that you should require a much stronger committment to mitigation from the company. Instead of passing a portion of the burden to someone else, perhaps the company could deed its reclaimed lands to the state so that intensive wildlife management would be more assured. Another possibility would be for the company to buy an equivalent parcel of wildlife habitat to be donated to the state for intensive management. Either of the above actions could be construed as a more sincere effort to mitigate the wildlife habitat loss that will almost surely take place.

Thank you for the opportunity to review the EIS.

Sincerely,

Robert R. Martinka

Robert R. Martinka
Project Leader
Coal & Energy Studies

RRM:fr

cc: James Posewitz

STATE OF MONTANA

DEPARTMENT OF STATE LANDS

MAILING ADDRESS: CAPITOL STATION
OFFICE: 1625 11TH AVENUE
HELENA 59601
(406) 449-2074

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AUDITOR

LEO BERRY, JR
COMMISSIONER

SCHOOL LANDS

The department agrees with this comment to the extent that rapid restoration of lost habitat is the most effective method of mitigating impacts imposed by strip mining. DSL should require that the following mitigating measures be taken relative to wildlife and wildlife habitat for WECo's proposed expansion:

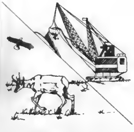
(1) deletion of mining disturbance in areas where initial wildlife use has been identified or where reclamation of such areas is doubtful

(2) make the reestablishment of wildlife population numbers in the proposed mine area a specific reclamation goal.

The following comment by WECo appears to be true:

> *WECo does not own the majority of the land which will be mined.*

In the content of DSL's responsibilities, however, this is immaterial, since WECo assumes responsibility for compliance with the reclamation standards when a permit is issued. The property is subject to the requirement of the Act, and the department is responsible for assuring that the reclamation plan is followed.



NORTHERN PLAINS RESOURCE COUNCIL

Main Office
419 Stapleton Bldg
Billings, Mt. 59101
(406) 248-1154

Field Office
P.O. Box 886
Glendive, Mt. 59330
(406) 365-2525

July 15, 1977

Commissioner Leo Berry
Department of State Lands
Capitol Station
Helena, MT 59601

Dear Commissioner:

Thank you for the opportunity to comment on the Draft Environmental Statement for Western Energy's expansion into Areas A and E for an additional 1844 acres.

What concerns us most about the Draft Statement is that Western Energy is proposing another huge expansion of its mines before there has been any successful reclamation in the area. Although no land has stood the test of time under the current Reclamation law, which passed in 1973, the results to date of land in the process of reclamation are not all that encouraging.

The Draft statement points out that "the ability to reclaim strip mined crop land to its original productivity is somewhat questionable, if normal fertilizer rates are used." That conclusion was drawn from results of research done by the Montana Agricultural Experiment Station on spoils at Colstrip in 1974. (DES, p.161)

The Draft concludes from the research that "available data from the Colstrip area indicate that the winter wheat productivity of the original native soils is not obtainable on reclaimed spoils even with extremely heavy applications of fertilizer. Without high applications of fertilizer the yield was even more drastically reduced on mine spoils." (DES, p.159-61)

While the law requires that the operator return the land to a self-sustaining condition capable of supporting the same grazing pressure, withstanding drought and preventing soil erosion as well as prior to strip mining, the land must be able to grow the same quality and variety of vegetation as it did before. Clearly, the spoils in the research area would not have met that test and speak against any change in the law to return strip mined land directly back to crops.

The Draft EIS also points out that the area would also lose the diversity of plant communities after strip mining since the reclamation plan restores the mined area to a very uniform soil type. (DES, p.162) The loss of diversity is a factor bearing on the land's ability to sustain pre-mining grazing pressure.

Recent results of another study underway at Colstrip show that grasses on native soils supported cattle better than strip mined land. Cattle grazing on unmined land gained 1½ times as much as cattle grazing on spoils grasses last summer. The limited diversity of spoils grasses may have been a factor in the low weight gains of cattle on the spoils vegetation.

Throughout the Draft Statement appear questions as to whether reclamation will succeed. Yet, the Draft seems to justify the possibility of a failure in restoring the agricultural productivity of the Colstrip area by saying: "Under present economic conditions and national priorities, the demand for coal greatly exceeds that of the agricultural products raised in the Colstrip area." (DES, p.228) We wonder how the State Land Department got that market information - from a national demand survey, from an internal executive order of the President, from a coal company brochure, or from some other authoritative source? Hopefully, that comment and the biases it represents will not appear in the Final statement.

We ask that the Final Statement incorporate specific procedures to guarantee reclamation at Colstrip. The Draft alludes to the fact that much more information exists on "possible successful reclamation techniques than that which is currently being used in the area." (DES, p. 204) Rather than allude to those techniques after making statements of the possible failure of reclamation at Colstrip, the Final should itemize specific steps to achieve success.

Concerning the air pollution violations at Colstrip, we whole-heartedly endorse the DEIS recommendation #4 - "The tipple should be covered to reduce the levels of coal dust as done at other mines in Montana." The Colstrip area has been in violation of the Federal Ambient Air Quality Standards since 1974. We are glad that the Draft has identified this problem and hope the Department implements this recommendation.

Sincerely,

Sarah Ignatius

Sarah Ignatius
Research Coordinator

cc: Brace Hayden

STATE OF MONTANA

DEPARTMENT OF STATE LANDS

MAILING ADDRESS: CAPITOL STATION
OFFICE: 1625 11TH AVENUE
HELENA 59601
(406) 449-2074

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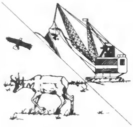
SCHOOL LANDS

MINING

RECLAMATION



Neither the reclamation act nor the plan requires a "guarantee" that reclamation will succeed in a given area. If the act and the plan could "guarantee" performance and success, there would be no need for a bond requirement. The department is obligated to evaluate the data and information required under the law and regulations and based on that evaluation, make a decision as to whether it believes the act has been complied with and whether the reclamation as proposed will succeed. If that decision is affirmative, a surface mining permit will be issued.

There is a continuing effort to gather new information on effective reclamation techniques. As with any new field, those techniques are in various stages of development. The department is evaluating as much information as possible to determine their effectiveness and desirability. When sufficient information is available to make that determination, the department will take whatever steps are necessary to incorporate the desired techniques into the program.

Montana State University
College of Agriculture
Animal and Range Sciences Department
Agricultural Experiment Station
Bozeman, Montana 59715
Tel. 406-994-3721

August 11, 1977

Commissioner Leo Berry
Department of State Lands
Capitol Station
Helena, MT 59601

Dear Commissioner:

I have become aware of a number of references to Montana Agricultural Experiment Station (MAES) reclamation research at Colstrip within the Draft Environmental Impact Statement for the Western Energy Company expansion into Areas A and E and its public review. I am presently principal investigator on MAES revegetation projects at Colstrip. Since some misinterpretation of research results--particularly of the grazing project--was evident to me upon reading some of the public criticisms of the EIS (specifically the N.P.R.C. letter of July 15, 1977), I felt it necessary to send you this letter.

The N.P.R.C. letter of July 15, 1977, points out that cattle grazing on native rangeland last summer gained $1\frac{1}{2}$ times as much weight as cattle grazing on spoils in the MAES forage evaluation-response study. While this fact was true, it was taken somewhat out of the total context of the study in question, and if taken without reference to the rest of the study could be very misleading as to the ability of the given spoils vegetation to support cattle. The spoils vegetation under evaluation in this particular study was composed primarily of introduced pasture species, and as such would not meet current State of Montana revegetation guidelines. It was established prior to the 1973 reclamation law, and is certainly not representative of the type of revegetation currently being implemented. This vegetation is being evaluated primarily to determine the utility and stability of introduced vegetation on mine spoils as special use pasturage during the spring, with rotation of cattle to native pastures during the summer (i.e., complementary grazing). Although results must be considered preliminary until several years of study have passed, initial data do suggest the utility of introduced spoils vegetation for spring grazing, at least from a cattle weight response standpoint. The only direct comparison of cattle weight response between introduced spoils vegetation and native rangeland has been during the summer grazing period, and this comparison did indeed demonstrate the apparent superiority of native vegetation to introduced spoils vegetation during that period. There is nothing surprising in this pattern. Much preceding grazing research in the Northern Great Plains region has indicated a similar seasonal forage quality relationship of introduced to native vegetation on native soils. This seasonal pattern would tend to support the concept of complementary grazing when and if introduced species dominate spoils plant communities.

The N.P.R.C. letter also implied that the limited diversity of the spoils vegetation may have been a factor related to lower weight gains on spoils in the summer. There really is no consistent, demonstrated relationship of forage diversity per se to cattle weight response. Weight response is more directly related to quality of existent forage, whether it be simple or diverse.

The concept of vegetation diversity is more appropriately linked to plant community stability in response to grazing, weather patterns and other factors. The introduced vegetation pastures of this study certainly are less diverse than good condition native rangeland. For this reason we are also closely monitoring plant community and site characteristics concurrently with livestock responses. These data will ultimately provide an indication of the stability of introduced species on mine spoils with grazing pressure.

It must be emphasized again that the experimental spoils pastures of this study are not truly representative of current (post-1973 law) revegetation on mine spoils. It is anticipated that within two to three years sufficient spoils acreage revegetated more prominently to native species will become available for grazing evaluation. Grazing research will then be expanded to these areas. Research on native species revegetation is progressing well and yielding much more promising results than initial efforts in the past.

Results of any field of research are certainly open to interpretation and criticism by all. However, most meaningful interpretation will usually come from the scientists performing the work or from other qualified professionals. If you have any questions pertaining to MAES reclamation research, please feel free to contact members of our staff. There is indeed no dearth of reclamation problems remaining to be addressed; if this was not the case, there would be little need for continued research. I am enclosing for your review a copy of the first year progress report of the spoils forage evaluation-response study. Review of this report should clarify the scope and intent of this often-misinterpreted study.

Again, please contact me if you have further questions on our research.

Sincerely,

Edward J. DePuit

Edward J. DePuit, Ph.D.
Asst. Research Plant Ecologist

ED:jf

Enclosure

July 15, 1977
Scott Fisher

Review of Draft EIS for Proposed Expansion of Western Energy Company's Rosebud Mine into Areas A and E.

General Review:

1. Soils belong in the Biological Environment (II.B.) instead of Physical Environment (II.A.) Soils are a basic component of the ecosystem, include an extremely important biological fraction, and are closely correlated with the composition and productivity of the associated biotic community.

2. The environmental impact on the soil resource is not addressed under III. (Environmental Impacts) and this represents a serious mistake.

3. Appendix B-1: Soil Descriptions and Test Data is incomplete.

4. Graphics and photographs are poorly constructed and reproduced.

5. Appendix has no table of contents and is poorly organized.

Analysis of Statement Content:

II. A.5. Soils and overburden

General Comments:

1. The following important elements are missing from the soil resource discussion:

a. The area of each mapping unit represented in each of the legends.

b. The capability classification and range site for each of the mapping units needs to be listed in the writeup.

c. The classification, at the subgroup and family levels, of each taxonomic unit recognized in the survey is necessary for proper evaluation of the soil resource data.

d. Summary charts of the chemical and physical data for the dominant taxonomic units recognized in the inventory should be included.

e. Potential productivity levels should be given for each mapping unit for both rangeland and more intensive forms of agriculture.

2. What is the scale of the aerial photograph of Figures 13 and 14? The scale indicator in the lower right hand of the legend box is illegible.

3. Straighten out the difference in reclamation potential between series like Bainville, McRae, Elso and Tullock in comparison to Fort Collins and Thurlow. Definition of composition

of each mapping units is critical to the evaluation of Table 13. How much mapping of unit Eb (Bainville loam) is 20" deep and how much is 20" over the paralithic contact?

4. Realize that the soil system is a controlling factor in the ecosystems of the semi-arid plains. In many ways, the success of the reclamation effort will be dictated by the careful selection of soil materials. This soil section should have only summary data in it, but it should include sufficient information to evaluate the losses to be incurred by the proposed action and potential for mitigation.

Specific Comments:

p. 38. A summary table of soil analytical work should be included here.

p. 38. "...top soil salvage to depths over 4 feet (table 13.)" Top soil is generally defined as the A horizon. What is the source for your inclusion of the B and C horizons in the top soil? Biologically, the A horizon bears little resembelance to the C. This difference is absolutely essential in the selection of materials for reclamation. The sentence quoted is something less than correct. How much of the area is covered by Remmit, McRae and Thurlow? How much area is composed of mapping units Eb, Ec, El, Mc, Sa and Sb which are marginal materials, at best, for reclamation?

p. 41. The narrative section needs more hard information.

p. 42. Define the problem with overburden sampling and the restructions that his places on the interpretation and analytical results. In particular, the highly stratified character of the Fort Union and Wasatch formations have to be stressed.

p. 42. Table 14. What are the units for each column? 130% clay? Is the summary an arithmetic or geometric mean of one bore hole or samples at the same level over the area?

p. 43. On what basis is the first statement made? What constitutes "significant amounts"?

II. B.1. Native vegetation and agriculture

General Comments:

1. Why include native vegetation with agriculture?

Specific Comments:

p. 59. Where is the map illustrating the distribution of native plant communities on the two areas?

p. 59. There is no reference for Ecological Consulting Service (1975^a).

p. 59. How were the 13 vegetation (plant?) communities identified? Were they subjectively established or is there ordination or similarity matrices to support this conclusion? How can you equate the Westinghouse and Ecological Consulting Service established plant communities? Did you re-analyze this data to establish these similarities?

p. 59. "...table 18. This data is based on field work from typical vegetation communities in the vicinity of Colstrip, including sites outside of the immediate permit areas." Table 18 title - Vegetative Composition of Areas A and E. These statments are contradictory.

p. 60. Table 18. Why include the disturbance level? 35.5% of the 47.7 acres of mapping unit 111.2 is lost irrespective of whether it is mined or has associated structures on it. Why did you separate out the associated disturbance level in greater detail in Area E than Area A? Separate the two areas into two charts. Unless you have good data to support the combination, including use of data manipulation techniques, do not combine mapping units.

p. 66. Carefully review the scientific value and relative importance of these old strip mine spoils. Expand this section. Should these areas be excluded because of "scientific value"? Studied by who?

p. 66. Ecological Consulting Service (1975^{a}). Not in reference section.

p. 66. "A .5 or 1 square meter frame ..." The data from different size quadrats may or may not be comparable. Standard methods must be established for this type of work to insure data compatability. Why?

p. 67. ~~What~~ where are A.U.M. data?

p. 67. "...more extensive data may be necessary..." Concur and is required.

p. 67. Burlington Northern data may or may not be accurate. The Montana Agricultural Experiment Station or Soil Conservation Service are far better sources. Tie this productivity data to soil taxonomic and mapping units.

III. B.1. Vegetation and agriculture

Specific Comments:

p. 158. "Additional areas... of this vegetation." Sentence doesn't make sense.

p. 158. "...small grain production..." Under dryland conditions, with low or no fertilizer application describe the relative yields. What is known about biogeochemical cycles and potential uses for such grain?

p. 159. Ecological Consulting Service (1976^{a}). How was this conclusion reached? Do the methods and procedures utilized justify this conclusion? Expand this statement.

p. 159. Reference to the work of Meyn, Sundberg, and Young, should include the 1976 dat~~a~~e of publication.

p. 159. "** data from Sindclar..." Author's name should be Sindelar.

p. 159. Absolute or relative corner? What is the importance of the growth habit of the perennial grass species being grouped together? Compare Blue grama (Bouteloua gracilis) with Prairie sand reedgrass (Calamovilfa longefolia).

p. 163. "...includes possible permanent reduction..." Delete the word possible.

IV. A.4. Soils and overburden

Specific Comments:

p. 200. "...center handling..." Add the word on.

p. 200. (2) Add that the making of the detailed soil survey should be accomplished after the area has been staked to facilitate accurate evaluation of stripping depths for topsoil (?) storage.

p. 200. (6) These amendments would be of questionable value in much of overburden/soils of this area.

p. 202. Is cheat grass a native species?

Appendix B-1 Soil Discriptions and Soil Test Data

1. Not all of the taxonomic units are described or analyzed.

2. Where are the technical mapping unit descriptions?

3. How do you propose to compare the meq of sodium (Na) (extractable or exchangeable?) between the Remmit and meq of Na in the Thurlow series? The data presented for the Remmit series is expressed in terms of Na meq/100gm of soil while the Thurlow series data is expressed as meq/liter in a saturation extract? Methodologies must be defined.

4. Why is the discussion of soil t~~a~~oxicities included in Appendix B-2, Overburden Analysis -- Mine Area A and E ?

Appendix D-1 Detailed Description of Community Types of Areas A and E

1. Some of the mapping unit descriptions found in the section were apparently not mapped in these two areas - unit 111.1 as an example.

2. Range sites (SCS) were given on some descriptions and not on others.

3. Why wasn't there an attempt to address the relationships between the plant communities identified and the soil resource inventory? The information should be of particular value in study of reclamation potentials.

TO: Brace Hayden, Environmental Administrator, DSL
FROM: Dave Stiller, Hydrologist-Geologist, NPRBEIS State Team Dms
DATE: July 15, 1977
RE: Comments on the Draft EIS for the Proposed Expansion of Western Energy Company's Rosebud Mine into Areas A and E.

Having reviewed the above, I find it necessary to comment on portions dealing with hydrology. My general complaint is that it lacks detail sufficient to undertake a comprehensive technical review. Inasmuch as the document is intended as an integral part of the Northern Powder River Basin Regional EIS, comparable detail should be provided for the various proposed actions such that a competent regional analysis can be undertaken.

My more specific comments follow:

Chapter II. I did not find a description of the next lowest aquifer beneath the Rosebud coal seam. It is implied, however, that the Rosebud-McKay interburden is such an aquifer, but I find this untenable. Its areal variation in lithology, and generally thin occurrence, taken in conjunction with the apparent lack of hydrologic information on the interburden, make its depiction as an aquifer unlikely. Unless such data can be supplied to verify the implication, I believe it unwise to name this unit an aquifer at all. Moreover, the occurrence of the interburden adjacent to the Rosebud coal seam suggests that hydrologic impacts will be felt as heavily in the interburden as in any other defined hydrologic unit in the Colstrip area.

It is unclear as to whether or not the alluvium in East Fork Armells Creek will be directly impacted by the mining of Area A. The alluvium is the major groundwater source in the area and any disruption by mining or related activities could impact downstream users.

Chapter III. There is a notable absence of a map depicting the recontoured surface. It is impossible to estimate the potential for overland flow erosion without such a map. I find it odd that an analysis of erosion potential on the reclaimed surface is lacking when DSL mine inspectors and personal experience reveal that surface erosion at Colstrip may be the largest single hindrance to successful revegetation. The relationship of the reclaimed drainage net to the East Fork of Armells Creek in Area A is not adequately discussed or considered in the Draft EIS. If this information is included in the mine plan, I believe it should be included in your document.

Further, the mention of sediment control structures as being the cure for any erosion problems is poorly considered. If erosion should prove to be severe, such structures may well fill in and become useless in rather short order, whereafter downstream channel scouring may occur. How this would affect a decision to remove or not remove the structure following cessation of mining is unclear.

In summary, I find discussion of alternative groundwater sources to be poorly considered, and the entire prospect for surface erosion control to be essentially ignored. The former question may be easily answered, depending upon your data bank. The latter issue would not be so serious a deficiency if erosion were not already a problem in the area.

MEMORANDUM

July 15, 1977

To: Joe Elliott

From: Charles van Hook

Re: Areas A & E EIS Comments

p 24 and Table 6
It should be pointed out that the BN site, though located in area E, is not positioned to accurately represent mine induced particulate emissions. This station is located some 200-250 feet high (above ambient surface level) on a butte. The station is located to primarily monitor power plant emissions. Though the BN site does record higher levels than the McRay site, probably due to its mine location, its elevation reduces its ability to efficiently monitor ground level mine dust emissions.

p 27 and Table 8
Site #3, the Colstrip town site is discussed in terms of dustfall values recorded. This site is a residential site. Table 8 demonstrates excessive values for dustfall for a period 9-30-74 through 1-31-76. Tables 9 and 11 indicate a continued problem at this residential site. This same site is also served by a high volume particulate sampler which takes 24 hour samples about every 6 days. The area B EIS (1) published by DSL contained a display of High Volume sampling data for the period January through December of 1975. The annual geometric mean for this period was 86 micrograms per cubic meter, which exceeded National Ambient Air Quality Standards. However, we must recognize that any mean value, if presented singularly, does not accurately represent the conditions the populace is subject to. Based on a sample taken once every 6 days, the 24 hour maximum of 260 micrograms/cubic meter was exceeded four times, and high values near the maximum were experienced at other times. The highest readings were achieved during the summer and fall months. However, only one sample was reported for May and none for June.

This sampler location has drawn the attention of PEDCo Environmental (2), a contractor working for the Environmental Protection Agency, attempting to evaluate the air quality problems at Colstrip. In their second analysis of Colstrip, they tried to explain the high level of air pollution at station #3, and in doing so, made a close inspection of the site. Their findings are partially presented as follows:

> "However, the results of this linear regression analysis show that the model has grossly underpredicted concentrations at the Montana Power site." (station #3)
> "There are basically two potential explanations for the large error in model-predicted concentrations at the Montana Power site. First, there was possibly a local bias at the sampling location. Second, there were possibly insufficient emissions in the model.

Numbers refer to bibliography following text.

> "The potential for a local bias at the Montana Power sampler was evaluated during a recent on-site survey. (See Appendix B). The results of the survey indicated that there were no large particulate sources in the immediate vicinity of the sampler. However, two coal surface mines and a coal-fired power plant were located within one mile of the sampler. The general conclusion, based on the survey, was that the sampler was probably providing a representative sample of the ambient air in Colstrip. As this survey was performed in late 1976, it does not preclude the possibility that a bias did exist near the sampler in 1974. However, 1976 air quality data show the annual geometric mean is of the same magnitude as the 1974 mean (Table 3-9). The on-site survey and comparison of air quality data both indicate that the error in model-predicted concentrations is not due to local bias at the sampler.
>
> "There are several possible reasons why there were not enough emissions in the model. First, some large particulate source or sources could have remained unrecognized and could have been omitted from the modeling efforts. A review of existing information for the Colstrip area and the results of the on-site survey indicate that this possibility is unlikely. A second reason relates to the location of ground level area sources. The emissions from these sources are considered by the model to emanate from the centroid of the area source grid in which they are located. Since some of the area sources may actually be located closer to the Montana Power site receptor than the centroid of the grid containing the town of Colstrip, the air quality impact could be underestimated.
>
> "The third possible reason why emissions were underpredicted is that emission factors used to estimate emissions from surface coal mines were too low. The emission factors used are not based on sampling conducted at coal mines. Rather, these factors have been adapted for used (sic) at coal mines based on similarities between coal mining operations and those operations at other types of mines for which emission factors have been developed. The potential margin for error could be as much as an order of magnitude for several of the coal mining operations. It would appear that the emission factors used to estimate emissions from surface coal mining are the most likely explanation for the low predicted concentrations at the Montana Power site." (2)

The PEDCo analysis points out several important facts.

1. The state of the art in particulate modeling is not dependable.
2. Most if not all particulate emission factors developed for coal mining in the West are probably lower than actual emissions, possibly by an order of magnitude.
3. It is probable that larger amounts of mine particulates travel further than has been assumed.
4. There is a need for a monitoring system designed to actually demonstrate how the particulates in Colstrip relate to the various activities in the area.

Station #3 is a unique monitoring site in that it is both in a residential area and near a coal mine. In many remote mine areas, large amounts of dust are generated which normally concern only the respiratory systems of heavy equipment operators. However, the Colstrip monitoring station indicates a situation where a mining activity can affect a populated residential-commercial area.

Currently, the activities in areas A and B are slowly moving away from the town site. However, the area B expansion, coupled with the area A activity will provide a greater variety of directional dust sources when viewed from Colstrip. In other words, more points of the compass will be potential dust sources for the town, or, the wind directions which could deliver dust to the community have been expanded. The increased distance of operations is a positive factor in probably reducing concentrations. However, the smaller particle sizes are generally more transportable over greater distances, and these smaller particulates are of greater potential hazard to human and animal respiratory systems. Please keep in mind also, that during this entire period of mining activity, the mine has been utilizing watering trucks as a mitigation of dust. I have on many occasions observed the watering trucks working in these areas, and at the same time observed large amounts of dust blowing from mine operations into the town.

BIBLIOGRAPHY

1 Draft Entironmental Impact Statement for the Proposed Expansion of Western Energy Company's Rosebud Mine into Area B. Department of State Lands, July 26, 1976 Table 6, pg. 24

2 S.E. Montana Coal Resource AQMA Analysis PEDCo Environmental, Inc. March 1977 Pg.3-29 and Appendix B

Department of Health and Environmental Sciences
STATE OF MONTANA HELENA, MONTANA 59601

[redacted]
A.C. Knight, M.D.
Director

Air Quality Bureau
Cogswell Building
(406) 449-3454

August 30, 1977

Mr. Dave Janis
State Lands
Capitol Station
Helena, MT 59601

Dear Dave:

You asked for Air Quality Bureau rationale for the strip mine particulate air quality monitoring in the Colstrip Western Energy areas A and B.

We have within the Air Quality Bureau (AQB) been cognizant of particulate problems associated with coal mining operations. We have for several years gathered total suspended particulate (TSP) data within the Colstrip area and have observed TSP trend increases with intensified mining efforts.

When the AQB was asked to comment on the State Lands Western Energy Area B impact statement dated July 26, 1976, we utilized what data we had available to us. However, since there is very little present air quality information about coal strip mines, we asked Western Energy to install six TSP samplers as well as dustfall samplers.

Although several of the samplers could supply data which would be used in enforcement actions some samplers are installed immediately adjacent to facility activity areas and are not indicative of ambient air. This research type data when it is summarized by the AQB will indicate which specific mining operations cause the greatest particulate emissions. This information will then allow the AQB to study and to effect necessary emission reductions.

To date sample sites 3,4 and 6 have recorded some high TSP levels - far in excess of State and Federal Standards. This data will assist us in our study of area A and B mining operations.

We hope to be able to apply this data to other mine expansions and to future mines - but only after careful consideration of specific details.

Sincerely,

David Maughan

David Maughan
Air Analyst

DM:es

Department of Health and Environmental Sciences
STATE OF MONTANA HELENA, MONTANA 59601

AIR QUALITY BUREAU
Cogswell Building
(406) 449-3454

~~John S. Anderson M.D.~~
A. C. KNIGHT, M.D.
Director

July 22, 1977

Mr. Brace Hayden
Environmental Coordinator
Department of State Lands
Capitol Station
Helena, MT 59601

Dear Brace:

Here are our comments on the EIS entitled "Proposed Expansion of Western Energy Company's Rosebud Mine into Areas A and E." We realize that these comments are late so acceptance or rejection of them are strictly up to you.

Our comments are:

1. Pages 27 & 31 - Dustfall at site no. 3 should meet the 15 T./mi^2 mo. standard, not the 30 T/mi^2 mo. standard.
2. Page 142 - Typographic error.
3. Page 143 - Typographic error in table 36.
4. Page 144 - "Particulate concentrations are generally below standards." Then they must occasionally be above standards!
5. Area A mining will be closer to the county road than in the past. This will cause higher TSP levels along this road than experienced in the past. Possibly some reduction in TSP levels in Colstrip will be seen.

Page 199 - What coal handling facilities will be used? One mitigating measure is to cover the tipple, "as done at other mines in Montana." What other mines?

Page 219 - Hopefully there will be no lasting effect on air quality. However if revegetation does not provide as good a ground cover as the original vegetation, possibly more dust will become airborne by the wind.

Page 224 - I'm not sure we agree that the degradation of air quality is within "acceptable limits."

Page 9 - No description is given of what happens to the coal after it leaves the mines. Are the present coal handling facilities going to be used?

Fig. 6 - It appears that possibly as many as three cuts could be open at any one time in area E. If this is true, is this more activity than what has previously occurred in area E?

We apologize for being so late and hope these comments are beneficial.

Sincerely,

Fred O. Gray
Environmental Engineer

FOG:ms

Thomas L. Judge, Governor

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION **DNRC**

MEMBERS OF THE BOARD - CHAIRMAN CECIL WEEDING, DR. WILSON F. CLARK, VIOLA HERAK, WILLIAM BERTSCHE, DAVID G. DRUM, ROY HUFFMAN, CHARLES HASH

John C. Orth, Director

July 15, 1977

'77 JUL 15 PM 4:20

Mr. Brace Hayden
Environmental Coordinator
Department of State Lands
Capitol Station
Helena, MT 59601

Dear Brace:

The Department of Natural Resources and Conservation would like to offer the following comments on the Draft EIS for the Proposed Expansion of Western Energy Company's Rosebud Mine into Areas A and E.

1. Total Suspended Particulates. (p. 25-27). Exactly why federal and state standards were exceeded should be explained. This explanation should include both the processes of particulate suspension and specific measures used by WECo to reduce particulate levels. For instance, to what extent has road surfacing and watering within the mining area mitigated existing problems and what additional measures are needed to bring the mine into compliance with state and federal standards. Actions by State Lands and the Air Quality Bureau in response to these violations should be noted.

2. Dustfall. (p. 27-28). The text should make some determination of how significant the environmental consequences of dustfall in the area have been.

3. Soil. (p 38). The average reader often construes the meaning of the term "soil" differently than a soil scientist. Therefore, without quantitative information on soil thickness, terms like "very thick" or "shallow" have little explanatory value.

4. Air Quality. (p. 142-145). A more sophisticated estimate of particulate loading due to travel on unpaved roads could be made if average wind velocities, soils data, and information on the size and number of hauling trucks were used.

32 SOUTH EWING, HELENA, MONTANA 59601 (406) 449-3712

Assuming that the two micron or less particulate fraction is primarily responsible for distant object vision impairment, what percentage of the TSP does this represent?

The statement on page 144 indicating that additional activity beyond present levels in the mine area could result in TSP standard violations is contradictory to earlier statements (p. 25 and 27) that standards are already exceeded.

5. Sediment Retention Ponds. (p. 146-147). A description of sediment retention ponds should be given, including design considerations enabling these structures to accomodate exceptional floods and an assessment of the condition and maintenance of ponds currently in use.

6. Errata.

   a. Figure 12 (p. 34). It is difficult to consistently tell the difference between coal and sandy shale in the Legend.

   b. Page 36, first paragraph, third line. "The Rosebud seam... has a thickness of about 1725 feet..."

Thank you for this opportunity to comment.

Sincerely,

Wayne Wetzel

WAYNE WETZEL
ENVIRONMENTAL COORDINATOR

WW:bjh

OLSON–ELLIOTT & ASSOCIATES
SCIENTIFIC CONSULTANTS

P. O. Box 1209
349 Last Chance Gulch
Helena, Montana 59601
Phone: (406) 443-5560

August 3, 1977

Mr. Brace Hayden
Department of State Lands
State Capitol
Helena, Montana 59601

Dear Mr. Hayden:

Enclosed are the responses of Olson-Elliott & Associates to the comments on the WESCO areas A and E Environmental Impact Statement. Only the vegetation and wildlife sections are addressed.

Our firm has also provided editing to the draft EIS in addition to the responses to the comments. This editing was submitted earlier. Inadvertently, however, the rough draft rather than the edited version was included in the draft EIS statement.

Sincerely,

Dana C. Schmidt
President

Enclosures

DCS/dmp

P.S. The response to the question from the NPRC, page 204, should be augmented by DSL personnel. You should respond to this statement as to what is being done different and what requirements are necessary in this permit to insure erosion conditions that exist in the pit 6 area do not happen again.

RESPONSES OF OLSON-ELLIOTT AND ASSOCIATES TO COMMENTS ON THE WESCO AREAS A AND E ENVIRONMENTAL IMPACT STATEMENT. (Only the vegetation and wildlife sections are addressed.)

Letter From:

Northern Powder River Basin EIS Study Team (Individuals listed).

Bret Brunner:

Page 2, in reference to page 59. The vegetative communities apparently differ in levels of resolution. The equating of these types was from data supplied with the permit application by Western Energy. These maps were prepared by Ecological Consulting Service. The maps were apparently inadvertently omitted from the EIS and should have been listed as figures 18 and 19 (Areas A and E respectively). There was no available information as to the basis for defining map units prepared by either ECS or Westinghouse. The types that were equated are listed on Attachment A. No information was supplied as to how these types were equated. (NOTE: These deficiences were pointed out during the EIS preparation to the DSL.)

In reference to page 76. This statement is correct. The fisheries were developed by stocking and a put and take situation.

Scott Fisher:

In reference to section II.B.

General comments: 1. The native vegetation and agriculture were grouped together in the discussion because available data and maps had both been presented. To facilitate writing and data tabulation of acreages, these were described in the same section.

Specific comments. page 59. Refer to answer to Bret Brunner, EIS team.

Page 59, Item 2. The references were incorrectly listed throughout the wildlife and vegetation sections, apparently because of errors in compilation of the various sub-sections into a composite EIS. The (1975a) reference should be listed as follows:

> Ecological Consulting Service, 1975a, Areas A and E Vegetation Maps.

Page 59, Item 3. See statement to Bret Brunner.

Page 59, Item 4. The statement, "This data is based on field work from typical vegetation communities in the vicinity of Colstrip, including sites outside of the immediate permit areas." should be deleted.

Page 60, Table 18. Disturbance levels are different and reflect bonding requirements. The associated disturbance categories may not be 100 percent affected as are the mining areas. The soil profile is not entirely disrupted as are the mining levels and will probably reflect reclamation difficulty. The associated disturbance levels presented are those depicted on maps for each area obtained from Western Energy. These disturbance levels were not grouped and mapping units were not combined. The data is separate although both are listed in Table 18. Pages 60 and 61 cover area A only and pages 62-65 cover area E only.

Page 66. These spoils have been studied by Brian Sindelar, MSU and other researchers from this institution. More details are included on pages 77, 78, 159, 160, 161, and 232 and a discussion of their value by Brian Sindelar was included in the Appendix.

Page 66, Item 2. The reference should be listed in the bibliography section, page 240, as Ecological Consulting Service, 1975a, Western Energy Vegetation Production...etc.

Page 66, Item 3. Data from different size quadrats may not be directly comparable. However, different investigators, and even the same investigators, vary their sampling techniques and procedures from year to year. Present guidelines of the Department of State Lands for such surveys require only that the method be documented and do not necessitate standardization. The methods are left to the discretion of the investigators.

Page 67, Item 1. AUM data are presented on Table 20, page 70.

Page 67, Item 2. Data deficiency was pointed out to the DSL during EIS preparation.

Page 67, Item 3. Available data from BN describes yields obtained from their land for the years listed in the Appendix data. Information as to potential or probable productivity of particular soils types in this region should be available from the Montana State Experiment Station or the S.C.S. This should be covered in the soils section of the EIS.

Page 158, Item 1. See edited change.

Page 158, Item 2. Yields on experimental plots of reclaimed area with variable fertilization are described by MSU researchers as follows:

Species	Yield (bushels per acre)			
	mine spoil			native soils[4]
Barley	40[1]	34[2]	7[3]	60
Oats	36	28	7	50
Speltz	29	16	5	80
Spring wheat	26	18	5	20
Winter wheat	15	9	4	45-48

1. Fertilizer rate 40-50-20 lbs/A N, P_2O_5, K_2O.
2. Fertilizer rate 90-121-45 lbs/A N, P_2O_5, K_2O.
3. Fertilizer rate 0-0-0
4. Fertilizer rate 6.4-8.0-0 lbs/A N, P_2O_5, K_2O

Data adapted from: Meyn, Richard L., Eric S. Sundberg and Richard P. Young, 1975, Research on Reclamation of Surface Mined Lands at Colstrip, Montana. MAES, Bozeman, Montana, 84 pp. Research Report 101.

Biogeochemical cycles on the reclaimed areas should be included in the soils section.

Small grains grown on the area A lands have been predominantly winter wheat and are commonly used for flour.

Page 159, Item 1. The reference cited is incorrect. This should be Sindelar and Plantenberg, 1977, instead of ECS, 1976 a. The coverage data from this reference for native range site 1924-4 and site 1932 are presented on page 160. Production data in the reference shows a similar comparison. Although statistical evaluations of the data and long term trends were not evaluated for these sites, the data presented indicates insignificant differences between these sites. Methods used were standardized coverage transects and clipped production plots. Sampling size appeared to be adequate to support this statement, but has not been evaluated in detail.

Page 159, Item 2. Note edited correction.

Page 1, 159, Item 3. Assume writer refers to Figure 21, page, 160. Note edited correction.

Page 159, Item 4. Also referring to Figure 21. Coverage values are absolute (i.e. totals of all species may reflect values greater or less than 100%.)

Page 163. The ability of new research and techniques to establish productivity of reclaimed lands to equal the crop land's original productivity is always a possibility. Different reclamation procedures will have to be used if this reduction is not permanent.

Page 202. The term "native" was used in the context of describing plant species on the area before mining, reseeding or other major land disturbances. Such plants which naturally invade because of grazing pressure etc., include many species which are found occurring on native range land in the area such as Dandelion, Kentucky Blue Grass, etc. None of these are true natives of the area.

Appendix-D-1. Item 1. This information was taken directly from the reference cited. It includes plant communities found outside of the immediate study area.

Item 2. Range sites are listed for each site on page 70, Table 20.

Item 3. There was no correlation of soils data for the study area with the vegetation data by the authors of the vegetation studies used in preparation of this EIS. This deficiency was directed to DSL during the EIS preparation.

END COMMENTS FROM SCOTT FISHER.

Dwayne Ward: No comment.

Social Impacts Section: No comment.

Charles Van Hook: No comment.

END COMMENTS TO THE N.P.R.B.E.I.S. TEAM.

Air Quality Bureau

Fred Gray: No comment.

Environmental Information Center

Alan Abramson: No comment.

Department of Natural Resources and Conservation

Wayne Wetzel: No comment.

Mrs. E.M. Kluver: See response to Northern Great Plains Resource Council below.

Northern Great Plains Resource Council

Sarah Ignatius:

The statements made are correct, however, the permanence of the existing reclamation achievements and failures cannot be established and long term productivity awaits further measurements and observations before any conclusions can be made.
The statement on page 228, referring to present economic conditions and coal demand was not meant to be a statement of policy for the Department of State Lands, but rather a generalization of the following facts:
---The federal government is continuing coal leasing in the area.
---The President has announced that coal will be used to satisfy some of the energy demand.
---Owners of the surface and mineral rights on areas A and E have chosen to use the land for coal production rather than agricultural production, presumably because of economic incentives based on the marketplace demand for the two products.
In other words, the statement was meant to state only the obvious reality of why coal development is occurring in the area. To avoid further misinterpretation of the statement, the following is entered instead:

> "Owners of surface and coal in the Colstrip area have chosen to forego agriculture and livestock production on certain parcels of land and have developed the coal resource, presumably because of the economic incentives of coal exceeding that of agriculture and livestock production."

Thus, it is obvious that agriculture is getting secondary consideration on the lands to be mined by the surface and mineral owners in some cases.

Page 204. The techniques available are numerous and complex. The reference cited is a bibliography of some of the methods available. Other techniques are apparently more successful on other strip mines in the area such as the Decker Mine. Apparently some changes are being made on the Pit Six areas which have had highly eroded sections. Specific steps which will guarantee success have not yet been determined.

END COMMENTS TO THE NORTHERN GREAT PLAINS RESOURCE COUNCIL.

U.S.D.I., Bureau of Outdoor Recreation

R.J. Arkins: No comment.

U.S.D.I., Bureau of Indian Affairs, Assistant Area Director

Item 3, Note edited change.

ECON

Robert E. Carroll: No comment.

ATTACHMENT A: RESPONSE TO BRET BRUNNER
CORRELATION OF MAPPING UNITS
ECON-Westinghouse

ECS PLANT COMMUNITIES	
111.1	Agropyron smithii-Bromus spp.-Poa spp.
111.2	Agropyron smithii-Koeleria cristata-Carex filifolia
111.3	Stipa comata-Carex filifolia-Koeleria cristata
111.4	Calamovilfa longifolia-Andropogon spp.
111.5	Bromus tectorum
211	Artemisia tridentata-Koeleria cristata-Agropyron spicatum
212.1	Artemisia cana-Agropyron smithii-Stipa viridula-Poa spp.
212.2	Artemisia cana-Agropyron smithii-Stipa viridula-Bromus spp.
213	Rhus trilobata-Stipa comata-Agropyron smithii
214	Chrysothamnus nauseosus-Agropyron spicatum-Oryzopsis hymenoides
220	Acer negundo-Fraxinus pennsylvanicus-Poa spp.-Agropyron smithii
351	Pinus ponderosa-Agropyron spicatum
352	Pinus ponderosa-Juniperus scopulorum-Agropyron spicatum
530	Agricultural
651	Disturbed grassland
652	Borrow area

CORELLATION[1]

ECS	WESTINGHOUSE
111.1	(9)
111.2	(5,6,11,12,19,23)
111.3	(1,3,12,18,20,21,26)
111.4	(2,4,25,27)
111.5	(24)
211	(10,15)
212.1	(9,13,22)
212.2	(14,22)
213	(1,18)
214	(25)
220	(9,13)
351	(7,8,16,17)
352	(8,16)
530	(Cult.)
651	(24)

WESTINGHOUSE VEGETATIVE TYPES

1. Stipa comata-Artemisia dracunculus
2. Calamovilfa longifolia-Stipa comata
3. Stipa comata-Boutelous gracilis-Carex filifolia
4. Schizachrium scoparium-Stipa comata
5. Gutierrezia sarothrae-Bouteloua gracilis
6. Stipa comata-Stipa viridula-Koeleria cristata
7. Pinus ponderosa-Stipa comata-Boutelous gracilis
8. Pinus ponderosa-Agropyron spicatum-Carex filifolia
9. Agropyron smithii-Poa pratensis-Artemesia spp.
10. Artemisia tridentata-Boutelous gracilis-Stipa comata
11. Agropyron spicatum-Carex filifolia-Agropyron smithii
12. Agropyron smithii-Koeleria cristata
13. Agropyron smithii-Poa pratensis-Artemisia cana
14. Agropyron smithii-Bouteloua gracilis-Artemisia cana
15. Artemisia tridentata-Agropyron smithii-Bouteloua gracilis
16. Pinus ponderosa-Agropyron spicatum-Bouteloua gracilis
17. Pinus ponderosa-Agropyron spicatum-Schizachrium scoparium
18. Stipa comata-Carex filifolia-Muhlenbergia cuspidata
19. Bouteloua gracilis-Aristida longiseta-Agropyron spicatum
20. Koeleria cristata-Stipa comata-Carex filifolia
21. Stipa comata-Koeleria cristata
22. Artemisia cana-Carex spp.-Artemisia dracunculus
23. Artemisia dracunculus-Carex spp.
24. Agropyron smithii-Bromus tectorum-Bromus japonicus
25. Agropyron spicatum-Schizachrium scoparium
26. Stipa comata-Carex spp.
27. Stipa comata-Schizachrium scoparium

Cultivated

---

1. Types were grouped and correlated by at least one or two dominant species occurring in each type.

[illegible] HOUSTON
ATLANTA LOS ANGELES
[illegible] NEW ORLEANS
[illegible] NEW YORK
BOCA RATON [illegible]
[illegible] [illegible]
[illegible] SALT LAKE CITY
CINCINNATI SAN FRANCISCO
CRANFORD SANTA BARBARA
[illegible] SEATTLE
[illegible] [illegible]
[illegible] [illegible]

DAMES & MOORE

CONSULTANTS IN THE ENVIRONMENTAL AND APPLIED EARTH SCIENCES

[illegible] MELBOURNE
CALGARY PERTH
JAKARTA SINGAPORE
JOHANNESBURG SYDNEY
[illegible] [illegible]
LONDON TOKYO
MADRID TORONTO
[illegible]

1620 ALDERSON AVENUE · BILLINGS, MONTANA 59102 · (406) 248-2641

July 28, 1977

State of Montana
Department of State Lands
Capitol Station
Helena, MT 59601

Attention: Mr. Brace Hayden
Environmental Coordinator

Gentlemen:

This letter contains our responses to the public comments received on the draft environmental impact statement (DEIS) concerning the Western Energy Company's mine expansion in Areas A and E, Colstrip, Montana. Specifically, our responses regard the comments received with your letter dated July 25, 1977, and which pertain to the physical environment section prepared by Dames & Moore.

Our responses to the comments are presented below according to the author of the comment and where applicable using the same item designation number.

Response to comments by Dave Stiller, hydrologist-geologist, NPRB EIS state team, July 15, 1977.

Chapter 2: As indicated on page 47 of the DEIS, the next lowest aquifer of regional extent that occurs beneath the Rosebud coal seam is the McKay coal seam. However, as also mentioned on this page, the interburden that occurs between the Rosebud and the McKay coal seams contains lenses of sandstone which probably are aquifers of local extent. The occurrence of these sandstone units are not predictable and they have no apparent trend. The hydrologic impact to areas where the sandstone interburden aquifer exists are expected to be negligible due to their generally small areal extent and also because these units will not be directly disturbed by the proposed mining. Also, negligible effects, if any, should occur to the underlying regional McKay coal aquifer.

Impact evaluations are not presented in Chapter 2 because this chapter discusses only the existing environment. According to the mining plan presented in Chapter 1, the alluvium in East Fork Armells Creek should not be directly affected by mining in Area A. Figure 5 on page 10 clearly delineates the proposed mined area. It is possible, however, as mentioned in Chapter 3, page 152, that mining in Area A could possibly intercept approximately 1,000 to 1,500 gallons of water per day that normally flows southeastward through the Rosebud coal to the alluvium of East Fork Armells Creek. Although no site-specific data is available for the volume of ground-water flow through the alluvium, it is expected that the amount of water restricted as a result of mining on Area A will negligibly influence the ground-water flow within the creek or its use by downstream consumers.

Chapter 3: Maps showing the post-mining topography were included in the Dames & Moore DEIS (see page 55 of our report). Apparently, the Department of State Lands (DSL) decided to exclude these from their DEIS that was made public.

We disagree with the author's statement that the sediment control structures are in existance as being a cure for erosion problems. To the contrary, it is mentioned that these sediment retention structures are erected for the purpose of capturing the sediment eroded from the area as a result of mining; it is a major mitigating measure. If erosion were to become a severe problem resulting in such structures being filled with sediment, then they would naturally have to be dredged to where the structures would have a capacity to maintain a storm runoff that meets applicable state and federal regulations. The decision to remove or not to remove the sediment retention structures following mining is made by the DSL.

The discussion on alternative ground-water sources was not addressed by Dames & Moore in our study. This topic was written by the DSL.

We do not understand Mr. Stiller's comments regarding the fact that surface erosion control was essentially ignored in the report. To the contrary, in the chapter on mitigating measures (page 200-201) a description of measures that could be carried out to mitigate surface erosion is presented.

Comments by Mr. Fred Grey, environmental engineer, Department of Health and Environmental Sciences, State of Montana, July 22, 1977.

1. The dustfall standards as presented in the DSL DEIS for the two sites identified as number 3, pages 27 and 21 are correct. The number 3 site shown on Figure 11 is considered a residential site since it is located in the town of Colstrip. As mentioned on page 27 of the DEIS, data shows this site has exceeded state residential standards for dustfall; also it has exceeded standards for an industrial site, a statement made only for comparative purposes.

There is an error at the bottom of page 27; the referenced figure should be number 10 and not 11. In changing this figure, the referenced station number 3 on page 31 is considered to be an industrial site, for which the dustfall standard is 30 tons per square mile per month.

4. Yes, the particulate concentrations are occasionally above standards as indicated in the baseline discussion between pages 24 and 31 of the report.

5. Comment referring to page 199. Examples of other mines in Montana that use covered tipple facilities are the Peabody Big Sky Mine and the Westmoreland Absalaka mine.

   Comment referring to page 224. The statement in which, "... the deterioration of air quality is expected to be within acceptable limits..." is qualified in the DEIS with the following statement, "...except possibly locally under unusual stable atmospheric conditions or immediately adjacent to mining equipment." With this qualification, we feel this statement is appropriate.

Comments by Mr. Allen Abramson, Environmental Information Center, July 15, 1977.

We agree that the amount of existing particulate data concerning the project area is sparse. However, based on the data available only a few selected sites are violating state and federal standards for settleable and suspended particulates. These sites are mainly within the mine boundaries, the exception being the town of Colstrip. The main activities believed to be causing these exceedances at Colstrip are vehicular traffic and construction of residences as mentioned on page 144 of the DEIS. Contribution of particulates from mining areas are probably minor except during periods of high winds. In other words, the exceedances at the town of Colstrip are an indirect effect of local activity resulting from the overall energy development within the Colstrip area. Implementation of the mitigating measures mentioned within the DEIS would probably result in much of the area coming into compliance with state and federal air quality standards.

It is difficult to respond to Mr. Abramson's comments that there are numerous vague and imprecise words and phrases throughout the air quality section when he does not specify the pages of concern. The examples he provides include, among other, "conditions appear to be marginal", "standards may be exceeded", "possible respiratory effects on human and animals", and significantly increased". On reviewing the air quality section where such phrases occur, we cannot agree that the interpretation in context can be taken as vague and imprecise. In all instances the phrases are substantiated with previously presented baseline data. Mr. Abramson is also disturbed that the comments on page 158 which show problems with dust affecting the vegetation, livestock, and wildlife and then the statement under the air quality portion that mentions, "...the deterioration of air quality is expected to be within acceptable standards except possible locally under unusually stable conditions or immediately adjacent to mining equipment." As is a common practice among most people opposed to surface mining or those that are "environmentalists", he is not placing the contribution of fugitive dust related to the mining venture in perspective with naturally occurring fugitive dust within the Great Plains region nor that contributed by the agricultural industry as a whole. As a result of the very few acres disturbed on a yearly basis by the mining venture, it will contribute very little to the overall fugitive dust problem of the region, whereas the amount of acreage disturbed annually by agriculture is by comparison greater by orders of magnitude.

Concerning his comments on the short statement in the mitigating section for air quality, we believe that these statments if implemented will adequately deal with the problems that are the result of the mining project.

Comments by Mr. Wayne Wetzel, environmental coordinator, Montana Department of Natural Resources and Conservation, July 15, 1977.

1. Chapter 2 which presents baseline data is not considered the applicable area of an environmental impact statement to present an explanation of why standards are exceeded. A discussion of the major reasons for such exceedances is presented in Chapter 3, Environmental Impacts, beginning on page 142.

   A classical textbook discussion on the parameters involved in wind erosion and particulate suspension are not considered necessary in an environmental report. Rather the direct causes are presented and not the physical aspects which result in suspension of particulates.

   To our knowledge, there does not exist qualitative or quantitative data regarding the extent that road surfacing and watering within the mining area has mitigating existing particulate levels. The mitigating measures presented in Chapter 4 if implemented would essentially allow the mine to operate in compliance with state and federal standards except possibly for unusual meteorological conditions. However, it should be noted that when such conditions occur, it often results in major erosion of non-vegetated or sparsely agricultural areas which, cumulatively, causes far greater environmental impact than the small area concerned with surface mining.

2. To our knowledge no scientific data exists regarding the significance of the environmental consequences of dustfall in the Colstrip area. However, a qualitative determination or evaluation is presented in the impact section on air quality beginning on page 142 of the EIS. Based on data from the site area, it is expected that cumulative impacts as a result of the proposed mining in Areas A and E will be minimal beyond existing conditions.

3. Concerning the terminology in regards to soil thickness "very thick" is greater than 4 feet and "shallow" is less than 1 foot in thickness.

4. The general discussion presented in Chapter 3 relative to particulate loading due to travel on unpaved roads is in our opinion adequate for the level of proposed mine activity and the data available. It would be inappropriate to conduct a sophisticated estimate for this aspect of fugitive dust when a comparable estimate could not be provided for fugitive dust related to blasting, coal preparation, coal loading and transportation, stockpiling, and reclamation. Besides, fugitive dust is not a major problem beyond the boundaries of the mine areas, except for those conditions mentioned previously; then, the major dust problem is in the town of Colstrip which is for the most part an indirect result of the coal energy development for the area.

   Data is very sparse concerning what percentage of the total suspended particulate (TSP) fraction is 2 microns or less in size. Normally, fractionating analyses are not performed on high filter samples. However, values were obtained as to the average particulate size for TSP samples collected between the period December 1973 and April 1974. Results of this analyses at the BN site south of Colstrip indicates that the average particulate size of 2 microns or less for this period was approximately 45 percent of the total particulate load (Draft EIS by the Montana State Department of Natural Resources and Conservation, November 1974, page 300).

   Concerning the contradictory statements between pages 144 and pages 25 and 27, the last sentence of the second paragraph on page 144 should read, "..., however, data indicate that concentrations at some stations within the mine will exceed standards with continuation of mining activity at present levels."

Errata - Page 25: First sentence should read as follows: "... collected by WECo in Areas A and B of the..."

Comments by Mrs. D. M. Kluver, resident of Forsyth, July 14, 1977.

In response to Mrs. Kluver's letter, the water use map presented on page 57 of the DEIS is a preliminary Montana Bureau of Mines and and Geology map subject to revision. Perhaps many of her concerns will be rectified in the map currently undergoing revision for this area. I am confident that Mr. Wayne Van Voast had appropriate answers for Mrs. Kluver's concerns.

Comments by Sarah Ignatius, research coordinator, Northern Plains Resource Council, July 15, 1977.

We have no response to Ms. Ignatius' comment letter since she has not referred any of her direct comments to the physical environment other than her concluding paragraph stating that she agrees with the mitigating measure no. 4 under air quality.

Comments by Mr. Barry, assistant area director, Bureau of Indian Affairs, July 18, 1977.

1. We do not believe it is necessary to provide a discussion on the status of the Northern Cheyenne Tribe's request for designation of air quality from a Class 2 standard to a Class 1 standard because the proposed action will not have any detrimental effect of measureable significance to the area or the Northern Cheyenne Indian Reservation, located 10 to 12 miles south of the Colstrip area. Effects as a result of the operation of the power plant at Colstrip is not a consideration in this EIS.

Comments by Bret Brunner, July 15, 1977.

Page 23: The severe weather section is related to the Colstrip area since the data covers eastern Montana in general where Colstrip lies.

Page 24-25: In reviewing the text, tables, and figures, there is a clear presentation of the monitoring stations named and their locations about the site area.

Concerning Mr. Brunner's comment, "...of why pollutant levels are what they are," it should be obvious that the levels are a result of the state of the existing surrounding environment, that is, surface coal mining primarily and other man-related activities as mentioned in the DEIS. Mr. Brunner mentions that there is no correlation of present levels with prior baseline conditions. Actually, the air quality data presented in Chapter 2 are the existing baseline conditions. These are the conditions that are established in an environmental report on which to base an analyses of impacts as a result of the proposed action, not prior baseline conditions that existed several years earlier. The DEIS does not need to contain a comparison or evaluation of present baseline conditions with those of an earlier date.

Mr. Brunner mentions that there is no indication of sources of pollutants. Perhaps the writeup of the EIS is somewhat negligent in not stating precisely that the pollutants measured are believed to be a result of the mining operations, but based on the distribution of monitoring stations which encircle the mine areas, it should be quite obvious that the large majority of the pollutants measured in regard to particulates is a result of the current mining operation and associated man activity. An exception to this is the monitoring station in the town of Colstrip where the major level of particulate pollution is probably caused by intown activities rather than the particulates being directly derived from the mine areas. In short, we cannot agree with his statement that, "...there is no way of determining a meaning of the data presented or of determining possible future trends."

Page 35: The brief writeup on seismicity was presented in the DEIS for overall completeness of the geologic discussion. Its little direct application to surface mining of coal at Colstrip is only the result of the area being of minor seismic importance. In some mine areas of the country mine design can be influenced by seismicity. Mr. Brunner mentions there is no indication of frequency of earthquakes. If he would divide the span of years since 1860 for which over 1,000 earthquakes have occurred in Montana (presented in the report), he would be able to derive an average frequency of 5.6 earthquakes per year. Concerning his last question "what is Zone 1?" as mentioned in the text, Zone 1 is the area in which only minor damage is expected as a result of ground motion from earthquakes.

Page 50: We believe the water quality section as written is clearly comprehensible and there is no necessity for a non-technical summary.

Page 56: A quantitative analyses on the distribution of water use has not been made for the Colstrip area. However, a general interpretation has been made based on the use of the local waters. For example, about 80 percent of the wells provide water for livestock. The remaining wells are utilized for rural-domestic and irrigation supplies. With this type of use one could assume that there would be a greater demand for well water during the summer months than other times of the year. Most water supplies for municipal and industrial uses within Colstrip are piped from the Yellowstone River. This type of use remains fairly constant year round for domestic purposes, but there would be a greater demand for industrial water during the warmer summer months than other times of the year.

Page 144: Concerning the contradictory statements between pages 144 and pages 24-51, the last sentence of the second paragraph on page 144 should read, "..., however, data indicate that concentrations at some stations within the mine will exceed standards with continuation of mining activity at present levels."

Page 157: We do not know why sound measurements were not taken in the Colstrip area. Perhaps the applicant was advised that such was not necessary.

Review comments by Scott Fisher, July 15, 1977.

General Review Comments

1. Although soils are a basic component of the eco-system, their discussion belongs in the physical environment since soils are not alive and are developed primarily through physical and chemical alternations of rock materials. An indepth discussion of soils does not belong in the biological environment section.

2. A concise discussion is presented on pages 148 and 149 of the DEIS concerning the environmental impact on the soil resource of the area to be disturbed by the proposed action. This discussion includes acreages of topsoil that will be disturbed for Mine Areas A and E.

3. Appendix B-1: Soils descriptions and test data appears complete to us. Specifically, what is missing?

Analyses of Statement Content

General Comment 1a: Specific data on the acreages covered by each specific soil mapping unit was not available for this study. Therefore, in our discussion, we generalized in describing the dominant and minor soil units for each mine area. For the interested reader, he could refer to the soils map and if necessary determine the approximate acreage for each mapping unit.

1b: The capability classification and range site for each of the mapping units was not available.

1c: The classification at the subgroup and family levels of each taxonomic unit recognized in the survey should not be necessary for proper evaluation of the soil resource data. A classification nomenclature at the subgroup and family levels is so broad that this provides only general information as to the characters of the soil. Of far greater use is the soil series data and analysis results of physical and chemical properties for the indidivudal soil types which is provided in the appendix.

1d: Although a summary chart of the chemical and physical data for the dominant taxonomic unit would be convenient data to have within the test, information of this nature is provided in the appendix.

1e: Presentation of data concerning the potential productivity levels for each of the soil mapping units is the type of data that would provide the reader with a general idea as to the suitability of existing soils for reclamation. Although this specific type of information is not delineated in the DEIS, in a detailed report information of this type would probably be presented in the vegetation sections.

2. The scale of the aerial photograph is 1 inch equals approximately 1370 feet.

3. The reclamation potential for each soil unit mapped is equated with its topsoil stripping depth and this data is provided in Table 13. A comparison between the various units is readily at hand by comparing topsoil stripping depths shown in this table.

   Again, the physical and chemical composition of each soil mapping unit is provided in the appendix.

   Based on Soil Conservation Service definition in which 85 percent of the soils in a mapped unit must meet the descriptive criteria for that unit, then 85 percent of soil in the Bainsville series would be 20 inches or deeper in depth before the paralithic contact is reached.

Specific Comments; Page 38: Although a summary table of soil analytical work would be a "nice" item to include in the text, it is not considered necessary. Since the data is presented in the appendix and for conservation of space it was not presented here.

The source for our inclusion of the B and C horizons in with the topsoil is from the recommendations presented by the Department of State Lands' under their guidelines for preparation of information pertaining to a strip mine permit (page 4 of their 1975 guideline issue). Accordingly, their definition is "Topsoil as used in the rules and regulations will be interpreted to mean any soil material suitable for topsoiling. Topsoiling materials will include the darkened A horizon, the B horizon if present, and the C horizon so long as it is determined suitable for topsoiling.

We agree that the soil baseline data for the mining areas would be better defined if the acreage values for the various soil mapping units were shown in the text. This data was not provided by the DLS or the WECo although it was requested by Dames & Moore at the time of preparation of our draft statement. Since WECo has mentioned they would not determine individual acreages covered by those units, the DSL mentioned that they would provide these acreages at a later date if it became necessary.

Page 41: Essentially the only additional information that would be helpful in the narrative section is a general discussion as to the acreages of individual soil units occurring on Mine Areas A and E. Much of the additional information that has been mentioned throughout these comments is contained either within the report or the appendices. Although one could always expand the narrative section, it would be mainly a discussion of information already presented in table form within the DEIS.

Page 42: It does not seem necessary that a discussion of the problems with overburden sampling needs to be placed in the text. A general discussion of the stratified character of the overburden sediment and problems associated with analyses is presented in the appendix.

As clearly defined within the title of Table 14 and also in the text, the units for each column are in feet. What is being presented is the depth intervals in feet for which potentially toxic levels of various parameters occur within specific core holes.

Page 43: The basis for the first statement made at the top of this page is obvious if one compares the summary analyses between Mine Areas A and E presented in Tables 14 and 15 respectively. Also, what constitutes "significant amounts" is clearly defined on page 42 for the varous common elements.

Appendix B-1:

1. A description is provided in the appendix as to the soils series level for each taxonomic unit described in the text. Accompanying this description are specific analyses for specific soil mapping units identified in Mine Area A and E.

2. As mentioned above, mapping unit descriptions are provided at the soils series level and not at the further breakdown for each soils type that occurs within this series which may occur on Mine Areas A and E.

3. We are not proposing a comparison of the meq of sodium between the Remmit and the meq of sodium in the Thurlow soils series as currently presented in the appendix. The results of these analyses for sodium on the two soils mentioned are based on different methodologies, the results of which are not directly comparable.

4. The discussion of soil toxicities was included in Appendix B-2 Overburden Analyses for the reason that the discussion centers on the toxicity of the overburden strata not on the surface soils. Perhaps the title should read, "Overburden Toxicities" rather than "Soil Toxicities" but used in the loose reclamation definition, soil includes the overburden material capable of supporting plant life.

We believe the above responses address all the comments of concern for which Dames & moore prepared the draft EIS section. If you should need any further clarification or have other questions, please do not hesitate to call us.

Sincerely yours,

DAMES & MOORE
Ted Rosengreen

Theodore E. Rosengreen, Ph.D.
Project Manager

db

WESTERN ENERGY COMPANY
GENERAL OFFICES: 40 EAST BROADWAY, BUTTE, MONTANA 59701.

August 23, 1977

Mr. Brace Hadden
Environmental Coordinator
Department of State Lands
Capital Station
Helena, MT 59601

Dear Brace:

Western Energy Company (WECo.) would like to submit the following response pertaining to the comments your department received on the DEIS relating to our mining areas A and E:

Comments of Fish and Game Department

Response: Basically, we agree with Mr. Martinka's statement that the burden of mitigation should fall on the party initiating the action. The Mining and Reclamation Program, in as much as possible, should be designed to minimize the effects of the proposed action on wildlife or any of the other resources. But in determining who will provide game management after mining and reclamation are accomplished, it must be realized that WECo. does not own the majority of the land which will be mined. Those lands that will be mined which WECo. has purchased generally have a revert back clause in the purchase agreement that will allow the previous owner to assume the ownership upon completion of reclamation. Therefore, we cannot dictate how the land will be managed after our bonds are returned.

Comments of Bureau of Outdoor Recreation

Response: No Comment

Comments of ECON, Inc.

Response: No Comment

Comments of Department of Natural Resources and Conservation

Response: Mr. Wetzel's suggestion to determine how significant are the environmental consequences of the dust fall in the area is a good idea. I would like to raise a question as to whether or not anyone has considered the fact that maybe the standards are not relevent to our conditions and even our area. Also are the conditions at Colstrip that much different than what can be found around many of Montana's small towns, especially those located next to highly intensified farming areas.

Further comments relating to the Air Monitoring Program are submitted later in the statement because of the large number of questions pertaining to the subject.

Comments of the Bureau of Indian Affairs

Response: With regards to the comments of the assistant area director, USBIA, it should be noted that a U.S. District Court has ruled that Colstrip Units #3 and #4 are not subject to the provisions of significant deterioration regulations (PSD). Further, we question the authority for the BIA statement that mines are considered to be a source of pollutants to be assessed under the PSD Regulations. The Northern Cheyenne Tribe has made statements to the contrary. WECo. would like to point out that our applications to the Department of State Lands has no relationship with Units #3 and #4.

Comments of the Department of Health and Environmental Sciences

Response: Mr. Gray's first comment indicates that there is some misunderstanding about Site No. 3. The DEIS discusses data from both WECo. air monitoring and MPCo., but both Companies have a No. 3 Site. MPCo.'s is located in town and WECo.'s was located next to the Area A and B coal storage pile. It was recently moved one quarter of a mile downwind from the storage pile as directed by Mr. Dave Maughan of the Air Quality Division. These two sites are now designated WE3 and MP3 for clarification. WECo. is in agreement with the Department of State Lands classification of the Colstrip Area as a heavy industrial area.

Comments of NPRBEIS State Team

Response: Although many of the comments submitted by the NPRBEIS state team are related to clerical and organizational deficiencies, they should be addressed by the authors of the DEIS. There are, though, some comments that WECo. would like to respond to. Mr. Fischer raised a question which deserves further consideration as it relates to The Montana Strip and Underground Mine Reclamation Act. His question of, "What is the source for your inclusion of the B and C horizon in the topsoil?", can only be attributed to the definition of topsoil in the act. The definition is a result of a geologist's attempt to burden subject operators with the requirement of saving all encountered materials suitable as a growth medium whether the material came from the A, B and/or C horizons or any combination thereof. This approach resulted in a mixing of the good topsoil material with submaterials that are of a lesser value. Recognizing the inequities of the definition of topsoil, Western Energy initiated a topsoil savage procedure that basically separates the A horizon within the soil types from the subsoil materials (B and C horizons). The subsoil material down to depths that exceed 4 feet are then saved and replaced over the regraded spoils prior to replacing the A horizon.

The vegetation communities determined by Westinghouse Environmental Systems and Ecological Consulting Service (ECON) were both based upon the two or more dominant vegetative species found in the areas. The consultants used two different means of referencing the various community types on the maps. When Western Energy contracted with ECON, Inc. to expand the survey to cover all of mine areas A, B and E, we also asked them to cross reference the vegetative community identification used by Westinghouse with the community types that they had found.

Mr. Stiller's comments pertaining to hydrology are in need of some clarification. The next lowest aquafer is the McKay Coal Seam as was reported in The Montana Bureau of Mines and Geology's Hydrologic Report of the Colstrip Area. Mr. Stiller raised some concern about hydrologic impacts that will be felt as heavily in the interburden as in any other defined hydrologic unit in the Colstrip area. We would like to point out that the interburden aquafer is very localized.

I reviewed Mr. Stiller's comment about "The alluvium being the major ground water source in the area and any disruption by mining or related activities could impact downstream users", with Mr. Wayne Van Voast of the Montana Bureau of Mines and Geology. Mr. Van Voast's comments on this issue were that "disruption will be slight, if any." "Some (disruption) could be beneficial in view of the reported water logging downstream".

Comments of E. M. Kluver

Response: Mrs. Kluver's comments about nonexistent reservoirs is correct as it relates to the one shown above the north edge of Section 12, T2N, R42E. The USGS shows the reservoir to be near the north line of Section 13, T2N, R42E instead.

> If there are wells and springs within three miles down dip of Western Energy's mining areas that have not been mapped, they certainly should be. The mapping of the springs and wells that was initially done using past records and the knowledge of the local people. If land owners have failed to make the necessary filings in the county courthouse of the springs and wells that exist on their property, there is no public records of such existance. In some cases, land owners were very restrictive as to who entered on their land to map such springs and wells and, therefore, it was easy for field investigators to overlook some of the springs and wells in the general area.

Environmental Information Center

> Response: No Comment.

Northern Plains Resource Council

> Response: Western Energy does not desire to submit any response to these comments other than we respectfully request that the Department make the Montana Agricultural Experiment Station's letter of August 11, 1977 a part of the record in that it clarifies some of the misconceived comments expressed about cattle gains on reclaimed spoils.

As a general response to the questions pertaining to the total suspended particulates exceeding the State and Federal Standards in the Colstrip Area, I would like to point out that Western Energy Company considers this to be a serious problem which is being actively pursued. Western Energy Company in cooperation with the other active parties to the power plant construction and the Air Quality Division of the Department of Health and Environmental Sciences is intensively evaluating the overall ambient air issue. I am attaching a copy of the plans submitted to the Air Quality Division outlining the compliance procedures for implementation to meet the ambient particulate standards. Some of the items that Western Energy is initiating to further mitigate the suspended particulates that have developed, is to purchase two more large water wagons in addition to the four that we now have for dust debatement. We are also investigating a larger source of water to be used for dust supression.

Periodically the question of covering our load-out facilities is raised because of the fact that other companies within the state have closed systems. It should be brought out that during the planning stages prior to construction of our load-out facilities, we weighed the benefits and disadvantages of having a covered system. Setting the overall cost issue aside, we would like to point out that having a covered system is far more hazardous in terms of safety than having an open system because of the high possibility of spontaneous combustion. Furthermore, technology relating to the erection of coal storage silos is not an exact science and if one researches this matter, he will find that many have collapsed in recent years. Furthermore, to have an open storage system of the type that we have and also in terms of size provides more convenience and flexibility in the shipping of coal.

Hopefully, this letter will help clarify some of the questions raised by those who commented on your DEIS. Thank you for the opportunity to respond.

Sincerely,

Michael R. Grende

Micheal R. Grende

MRG/llm/l:l

Attachment

COMPLIANCE PLAN FOR IMPLEMENTATION OF AMBIENT PARTICULATE STANDARDS

The following are steps that have and will be taken in order to identify and mitigate sources which may now be causing high values of total suspended particulate (T.S.P.) matter measured at the Ambient Air Monitoring Site MP #3 at Colstrip. However, first, it is submitted that the operation of Colstrip Plants #3 and #4 will not contribute to the specific area where violations of the total suspended particulates have been noted.

Secondly, it is submitted that high values of total suspended particulates may well be caused by non-industrial or so called "fugitive dust" sources, and therefore are not to be considered violations. In the event that the high readings in the Colstrip area are from "fugitive dust", a new source, such as Colstrip 3 and 4, is allowed to construct without the need of complying with EPA's interpretive regulations regarding offsets, as discussed below.

Thirdly, it is submitted that an "existing" violation is considered to be at the proposed sources start up date. Therefore if the reviewing authority finds that the area will not be in violation at the source's start up date (September 1981 for Colstrip Units #3) a source such as Colstrip 3 and 4 could not exacerbate an "existing" violation, and therefore is allowed to construct without complying with EPA's offset regulations.

Fourth, it is submitted that the "source" as set forth in EPA's offset regulations refers only to the boilers as measured at the stacks of Colstrip units 3 and 4. Furthermore, upon the basis of the Board of Health hearings and findings of fact and conclusions of law regarding Colstrip 3 and 4, it is submitted that Colstrip 3 and 4 represents the lowest achievable admission rate for particulates.

Even in the event that the coal handling facilities for Colstrip units 3 and 4 are also considered a "source", as used in EPA's offset regulations, it is submited that the existing coal handling facilities also represent the lowest achievable emission rate. Pursuant to EPA's notice of July 8, 1976, (41 Fed. Reg. 28002 et seq) the Federal Clean Air Act, as amended, 40 CFR 51.18 and EPA's interpretive ruling (41 Fed. Reg. 55524 et seq. Dec. 21, 1971) and the Montana State Implementation Plan -- steps being taken are: First, immediate steps are being taken to reduce the Total Suspended Particulates in the area, to obtain and offset from existing sources in the area greater than projected emission from Colstrip 3 and 4, so as to represent reasonable progress towards attainment of ambient particulate standards including:

1. A street sweeper has been purchased and the frequency of street cleaning is being increased and the areas being cleaned expanded.

2. Work is now under way to finish the landscaping immediately surrounding the plant administration building. The areas surrounding the service station and "snack shack" are scheduled to be paved by the end of August, 1977.

3. As soon as plans can be made, unstablized areas in the Colstrip town site under the control of the Montana Power Company or Western Energy Company, will be stablized with perennial vegetation.

4. The areas disturbed by mining will continue under the present program of reclamation as defined by State Law and conducted by Western Energy Company.

5. Annual vegetation existing in and around the town of Colstrip will be replaced with perennial cover where possible.

6. Owners of the property not belonging to either the Montana Power Company or to Western Energy Company are being contacted to determine their plans in correcting any unstablized surfaces under their control. It is our intention to offer assistance to these owners where needed and where practicable. (A major concern in this regard is the school where a large area surrounding recent construction and a large parking lot are both significant dust sources.)

7. Hardwood Lignin Liquor now at Colstrip will be diluted approximately 4.5 to 1 and applied to selected haul roads and accesses at the mine, to alleys and unpaved roads in the community of Colstrip. These applications are going to be evaluated as to the most efficient dilution factor, rate of application and frequency of application. Application will be made by large water carriers in the mine and by using the hydro seeder and a smaller truck around the community of Colstrip. Approximately 93,500 gallons of diluted lignin liquor are available on site for this preliminary evaluation.

In addition to these immediate mitigation measures which are being taken, the compliance plan also includes monitoring and scientific analysis. The Department of Health and the Montana Power Company are analyzing existing ambient air quality data and existing meteorological data. The Montana Power Company has retained Mr. Loren W. Crow, a consulting Meteorologist, (2422 South Downing Street, Denver, Co. 80210) to conduct this analysis. Mr. Crow's assignments are two-fold. First, Mr. Crow will look at the available data, i.e.; meteorological reports, suspended particulate data and recently compiled data on construction activity and surface conditions in the area of concern. From this evaluation a plan of immediate mitigation of apparent fugitive sources will be developed. Second, Mr. Crow will help prepare a long-term meteorological study to be used as an aid in policy decisions needed to achieve long-term air quality maintenance. Mr. Crow is also retained in a quality assurance position for both this long-term study and to overview our routine ambient monitoring program. We will continually analyze air quality and to determine causes of emissions. This will insure that we can change our on-going mitigated measures if necessary to effect compliance with the ambient particulate standards.

United States Department of the Interior

GEOLOGICAL SURVEY
Box 25046
Denver Federal Center
Denver, Colorado 80225
Water Resources Division
Stop 413

IN REPLY REFER TO:

August 3, 1977

Mr. Brace Hayden
Department of State Lands
Capitol Station
Helena, Montana 59601

Dear Sir:

Enclosed is a copy of the abstract from an extensive report by Perry H. Rahn. The results of his investigations indicated that a very much higher permeability can be expected from "dragline-emplaced" spoils than occur in undisturbed coal and overburden. Since dragline emplaced spoils tend to bulk by about 20% this large increase in permeability is to be expected. The compacted scraper-emplaced spoils do not "bulk" and do not exhibit any increase in permeability. Due to these high permeability dragline emplaced spoils will not tend to resaturate in a manner similar to the undisturbed coal and overburden. In fact unless the spoils are completely surrounded by undisturbed material the resaturation of the spoils will be confined to the lower few feet.

The permeabilities for spoils obtained by Van Voast as presented in his Coalstrip report are all very low and he concluded that there is little change between the permeability of the spoils and the undisturbed material. I do not believe Van Voast's results can be representative of dragline-emplaced spoils in the Coalstrip area. This could be because the more permeable part of the spoils are not saturated in this area, or it could relate to methods of drilling, finishing, and development of the well, or to methods of testing and interpretation of test data.

I am assuming in all of the work that I am doing that dragline emplaced spoils will have a much higher permeability than the undisturbed coal and overburden, and statements to the contrary should not appear in the site specific statements on Western Evergy areas A & E, and B.

Frank N Visher
Frank N. Visher

Enclosure

cc: Dave Stiller

Potential of Coal Strip-mine Spoils as Aquifers in the Powder River Basin
by Perry W Rahn, June 30, 1976

ABSTRACT

The Powder River Basin contains some of the largest coal deposits in the world. Despite the immense coal production that will undoubtedly occur in this area in the next few decades, little is known about the hydrology of the spoils that occur as a byproduct of strip mine operations.

The Tongue River Formation of the Paleocene Fort Union Group contains most of the strippable coal deposits in the Powder River Basin. Flat lying low sulfur coal beds up to 200 ft. thick are typically overlain by semiconsolidated shale and sandstone. Typical overburden to coal thickness ratios in working mines are 2:1. The overburden is generally dragline or scraper-dumped into the excavated pit.

Pump tests were conducted to determine the aquifer characteristics of the mine spoils of two coal strip mines in western Sheridan County, Wyoming. The results of the pump tests show an average permeability of 60 feet per day 450 gpd/ft^2 and an average storage coefficient of 0.170 for the Hidden Water Creek mine where dragline-emplaced spoils occur, and an average of 0.54 feet per day 4 gpd/ft^2 permeability and 0.233 storage coefficient for the Bighorn coal mine where scraper and bulldozer-emplaced spoils occur.

Six coal strip mines were studied using field infiltration and laboratory permeability apparatus to determine hydrologic characteristics. Data from 44 sites indicate that the permeability is primarily related to density, which in turn is due to method of emplacement and composition. Spoils emplaced by dragline show higher laboratory permeability than those emplaced by scraper or truck. This is presumably due to greater compaction caused by machinery moving over the surface of the spoils. Local stratigraphy, however, has a great influence on the hydrologic

characteristics of the spoils. Areas with large amounts of alluvium or sandstone in the overburden show significantly larger values of laboratory permeability than those where overburden consists chiefly of siltstone or shale.

Chemical analyses of 32 water samples show a significant difference of the quality of ground water in spoils compared to natural ground water from wells in the Tongue River Formation. Water in spoils contains greater sulfate, calcium, magnesium, and total dissolved solids. The solution of gypsum and oxidation of pyrite is believed to contribute to the high mineral content of spoils water. However, the mineral content of natural ground water is also sufficably high to limit its usefulness.

The possibility of utilizing the abandoned spoils as ground water storage areas is feasible due to the moderately high permeability. However, the poor quality of the ground water that would be pumped out of the spoils would appear to limit its usefulness.